DOCTOR OF PHILOSOPHY

Inequality, Redistribution and Mobility of Agricultural Incomes in Scotland

Kasprzyk, Kalina

Award date:
2014

DOCTOR OF PHILOSOPHY

Inequality, Redistribution and Mobility of Agricultural Incomes in Scotland

Kalina Kasprzyk

2014

University of Dundee

Inequality, Redistribution and Mobility of Agricultural Incomes in Scotland

Kalina Kasprzyk

Submitted for the Degree of Doctor of Philosophy

Department of Economic Studies

School of Business

University of Dundee

August 2014

Table of contents

List of Figures

List of Tables

Acknowledgements

This thesis would not have been possible without the guidance and the help of several individuals who in one way or another contributed and extended their valuable assistance in preparation and completion of my work.

First and foremost, I would like to thank my first supervisor Dr Paul Allanson, whose support, knowledge and patience has made this thesis possible. I would also like to thank my second supervisor Dr Carlo Morelli and my third supervisor Dr Andrew Barnes.

I am very grateful to the faculty members and staff of the Department of Economic Studies for their help and support, especially Professor Hassan Molana, Dr William Russell, June Campbell and Adele Ferrier.

The research behind this thesis was made possible thanks to the financial support of the Scottish Government and the Economic and Social Research Council. I would also like to thank the Scottish Government staff, in particular Cornilius Chikwama and Thomas Sharp, who was very patient with my many Farm Accounts Survey questions.

Declaration

I declare that I am the author of this thesis and I have consulted all the references cited. All the work of which this thesis is a record has been done by myself and has not been previously accepted for a higher degree. All the tables of results and figures, unless otherwise stated, are a source of my own calculations.

Kalina Kasprzyk

PhD Candidate

Date ……………

Signature …………………

Certification

I certify that Miss Kalina Kasprzyk conducted this research under my supervision in the Department of Economic Studies, University of Dundee. Miss Kasprzyk has fulfilled all the conditions of the relevant Ordinances and Regulations of the University of Dundee for obtaining the Degree of Doctor of Philosophy.

Professor Paul Allanson

1st Supervisor

Date……………

Signature …………………

Abstract

The purpose of this thesis is to analyse different aspects of the distribution of agricultural incomes in Scotland. More specifically, the thesis will first investigate the impact of agricultural income support on inequality through the analysis of its redistributive effect. Decomposition of the redistributive effect allows to determine if agricultural support has been progressive or regressive in absolute terms and whether discrimination between farms with equal pre-support incomes exists. Such assessment is performed both for actual data with the historic model of the Single Farm Payment (SFP) in place, as well as for counter-factual data generated by two hypothetical regional model distributions of the SFP; the latter is particularly informative in the context of the new Common Agricultural Policy (CAP) reform that will require all Member States to adopt area-based entitlements. In addition, the thesis will study the evolution of agricultural income distribution through the analysis of income mobility. The first focus of this dynamic analysis is to investigate the transition process underlying the evolution of agricultural income inequality over time. This is achieved by decomposing changes in inequality over time into the part which measures if income growth was progressive or regressive (vertical mobility) and the part which measures the resulting reshuffling of individuals within the income order (reranking mobility). The characterisation of the expected income growth process will indirectly examine the validity of Gibrat's law in Scottish agriculture. Furthermore, the determinants of vertical mobility will be investigated in order to analyse the impact of structural change and transitory shocks. The second focus of the dynamic analysis is to investigate whether the inequality in Scottish agricultural incomes is a transitory or structural problem, and

to what extent structural inequality is caused by differences in the economic size of farms.

1 Introduction

The improvement of the income position of the agricultural community is an important, although poorly defined, goal of agricultural support (OECD, 2003). This objective was historically met by providing assistance through the support of farm output prices, however successive reforms aimed to disconnect the payments from production levels. Thus market support measures were largely reduced and replaced with payments coupled to hectares planted and breeding livestock numbers. Eventually, the decoupled direct payments were introduced in 2005 in the form of the Single Farm Payment (SFP), which is paid out on a per hectare basis and independently from current production levels. The Single Payment Scheme (SPS) was introduced in Scotland using the historic model, which means that entitlement values received by individual farmers allow them to enjoy support levels comparable to the coupled support the SFP replaced. The historic model of the SFP implementation has been widely criticized as unjust and increasingly hard to justify, and the post-2014 CAP reform is intended to replace the heterogeneous entitlement values with flat regional rates, which implies changes in the support distribution in Scotland.

As a result of the switch to decoupled direct payments, the distribution of support became more transparent and open to manipulation, allowing the policy to be targeted in order to meet different policy objectives. The current distribution of support reflects many different goals, including environmental sustainability and rural development. However, one of the founding objectives of the Common Agricultural Policy (CAP) was “to ensure a fair standard of living for the agricultural community, in particular by increasing the individual earnings of persons engaged in agriculture" (Treaty of Rome, 1957). As such, farm income support remains one of the key objectives of the CAP, with the European Commission (1991, 2002) expressing concerns about the inequitable distribution of agricultural income support. Furthermore equity and targeting have been identified by the OECD (1998) as general operational criteria for agricultural policy evaluation.

In this context, the broad aim of this thesis is to analyse different aspects of the distribution of agricultural incomes in Scotland. More specifically, the thesis will investigate the impact of agricultural income support on inequality through the analysis of its redistributive effect and the evolution of agricultural income distribution through the analysis of income mobility.

The analysis of inequality closely links with the analysis of mobility, because as Yitzhaki and Wodon (2003, p. 2) note "formally, if we consider a bivariate distribution representing an initial and a final distributions, an inequality index is a summary statistics defined over each marginal distribution, i.e. the initial and the final distributions. By contrast, a mobility index describes the transition process between these two distributions." As such, looking at both aspects will provide a more comprehensive characterisation of the agricultural income situation in Scotland.

In terms of more specific objectives, the analysis of the redistributive effect of agricultural support primarily aims to show whether the provision of support in Scotland serves to increase or decrease absolute income inequality. Furthermore, by decomposing the redistributive effect, the analysis will investigate if the support has been favouring poorer or richer farms in absolute terms, and to what extent discrimination between farms with equal pre-support incomes takes place – both within a given farm type and between farm types. The methodology is based on Allanson (2008), who measured the redistributive effect in Scotland in years 2000/2001 - 2004/2005. While the majority of studies on the redistributive performance of agricultural support focus on its vertical stance (Keeney, 2000; Schmid *et al*., 2006, Von Witzke and Noleppa, 2007), Allanson's decomposition also addresses the previously neglected issue of horizontal inequalities in support provision.

The contribution of this thesis in terms of the redistributive effect analysis is threefold. Firstly, the measurement of pre-support incomes will be done using an improved approach to calculate the net value of transfers. Allanson (2008, Allanson and Rocchi, 2008) simply made assumptions about the passthrough of direct payments. Borrowing from the OECD (2003), he assumed that a return from a unit increase in direct payments to individual inputs is equal to the farm-owned share of those inputs. In the case of SFP, this assumption would imply zero passthrough for tenanted farmers. Since the SFP constitutes a large share of the agricultural support in the study period, it was important to replace this assumption with an empirical estimate to ensure the validity of the findings. For that purpose, the capitalisation of the SFP into rental rates of agricultural land will be estimated. Relatively little research exists on the SFP capitalisation, with estimates of capitalisation degree varying between 6% (Ciaian *et al*., 2011) and 41% (Kilian *et al*., 2008), and there are no estimates for Scotland specifically.

Secondly, the thesis will analyse the redistributive effect of support in Scotland after the SFP was introduced in 2005. This provides an evaluation of how the redistributive per -

formance of support was affected by the switch to the SFP.

Thirdly, the thesis will investigate how support would have affected inequality if a counter-factual regional, flat rate system of the SFP had been introduced instead of the historic model. This simulation is of policy interest in the context of the upcoming obligatory switch from historic to regional model of the SFP. Two possible scenarios will be investigated: a flat rate for all entitlements across the whole of Scotland, and two separate rates of entitlements for eligible Less Favoured Areas (LFA) and non-LFA land (which is in line with the proposal of the Pack inquiry into future support in Scotland (Pack, 2010b)).

To complement the static analysis of income inequality, the thesis will also perform a dynamic analysis through the study of farm income mobility. This area of study is largely unexplored; the only study of Scottish farm incomes dynamics is performed by Phimister *et al.* (2004) and covers the years from 1998/1989 to 1999/2000. The concept of income mobility has many different dimensions and the large literature on the topic does not provide a unified discourse. Jantti and Jenkins (2013) helped to clarify possible confusion by classifying the existing approaches into four different concepts of mobility. This thesis will use data for years 1995/1996 to 2009/2010 to explore all four of the concepts of mobility identified by Jantti and Jenkins, and as such it provides a first comprehensive analysis of the issue.

The first main focus of the dynamic analysis will be to investigate the transition process underlying the evolution of agricultural income inequality over time. Following the approach of Jenkins and van Kerm (2006), changes in inequality will be decomposed into a part that measures the impact of expected income growth, that is vertical mobility, and a part that measures the reshuffling of individuals within the income order, that is reranking mobility. This will show whether expected income growth in the Scottish agriculture is progressive, regressive or neutral in relative terms, and thereby indirectly examine the validity of Gibrat's law of proportionate effect for farm income growth.

Moreover, the vertical mobility index will be further decomposed in the manner of Allanson and Petrie (2013) through the use of a regression-based procedure in order to investigate how inequalities in income determinants affect the income growth. For the purpose of this decomposition, an Error Correction Model (ECM) of changes in agricultural income is estimated, in which income is modelled as a dynamic function of the economic size of farms. This specification allows investigating the roles of structural change and transitory shocks in inequality changes over time. The vertical mobility decomposition of Allanson and Petrie's (2013) is employed for the first time outside of its original application to the measurement of changes in income-related health inequality. The thesis extends their methodology by decomposing multiyear, as well as single year, changes in inequality.

The second main focus of the dynamic analysis will be to investigate whether the inequality in Scottish agricultural incomes is a transitory or structural phenomenon. The first method used to investigate this issue is the traditional measure of structural rigidity due to Shorrocks' (1978a), which compares the inequality of longer-term income averages to the weighted average of actual inequality levels observed in each year. This is complemented by an analysis based on a behavioural concept of equilibrium income based on the results from the ECM. Using estimates of the equilibrium income relation, the extent of chronic inequality in agricultural incomes will be measured, and the role of inequalities in the distribution of the economic size of enterprises in the determination of structural farm income inequality will be investigated.

1.1 The data

The thesis is based on micro-level weighted panel data from Farm Accounts Survey (FAS). The survey is carried out on an annual basis by the Scottish Agricultural College (SAC) for the Scottish Government in order to provide an in-depth analysis of the financial stance of Scottish farms. It covers most of the main types of full-time farms in Scotland, excluding specialist pig, horticulture and specialist poultry producers. It is carried out using farmers' financial years instead of calendar years, which will vary depending on the farmer, but the results are centered on the same production periods. As such, the range of years used covers 1996 to 2010, but this will correspond to 1995/1996 - 2009/2010 production years, which end in March. Thus for example data for 2006 will de facto be centered on 2005 production year (from 1st of April 2005 to 31st of March 2006).

The survey collects detailed information on up to 500 farms that are representative of all the main types of farms in Scotland. A wide range of information is collected, including production, sales, revenue, quotas, crop areas, subsidies and costs. The data is validated against assurance checks to provide reliable, quality information. In order to yield summary statistics for the whole population, the data is weighted by size and type, as well as tenure for balance-sheet tables, based on the information from the annual June Census on the population of Scottish farms.

The survey is meant to be representative at national level, however part-time farmers as well as those who have substantial involvement in non-farm or other agricultural activities are not included. For this reason the results can play down the incidence of pluriactivity of farms and the significance of non-farm sources of income (Allanson and Rocchi, 2008).

Table 1.1 Number of farms by number of years in the FAS sample.

Number of years in sample	*Number of farms*
1	83
2	121
3	82
4	53
5	64
6	53
7	79
8	43
9	15
10	30
11	34
12	42
13	48
14	44
15	151
Total	942

An important characteristic of FAS is that once a farm is recruited into the database, it can stay in the sample for unlimited amount of time, provided it remains a full-time commercial enterprise. This implies that linking data across many consecutive years allows observing changes in variables for the same farms. There is no formal account of attrition, but farms must remain in the sample for at least 2 consecutive years to be included in the Scottish Government's analysis. Together with the difficulty of recruiting new farms, this suggests that SAC will strive to minimise the attrition

(Phimister *et al.*, 2004). Table 1.1 shows the number of farms by the number of years present in the sample, which gives some support for the low attrition. In particular, 151 farms have been consistently present in the dataset for period 1996 – 2010.

1.2 Outline of the thesis

Chapter 2 provides an overview of the origins and developments of the CAP as a farm income support measure. It discusses what farm income problem is, how it was initially addressed by the CAP and how successive reforms throughout the history of the policy have altered its shape, introducing direct payments which have greater transparency and targeting potential. The purpose behind this chapter is to facilitate the understanding of the policy's current shape and set the ground for the subsequent analysis.

Chapter 3 estimates the degree of capitalisation of the SFP into agricultural rental rates. The SFP is linked to land through the requirement of eligible hectares needed to activate the entitlements; this has caused concerns among policy makers that landlords will be able to capture a substantial share of the support through higher agricultural rents. By estimating a rent equation, this chapter quantifies how much of the payment goes to the farmer, and how much is captured by the landlord in the form of higher rental rates for agricultural land. This result provides a numerical estimate of the SFP passthrough needed to calculate the net value of transfers in the subsequent chapter.

Chapter 4 measures and decomposes the redistributive effect of support following Allanson's (2008) approach. In addition to assessing the redistributive effect of actual policy in years 2005/2006 – 2009/2010 with the historic model in place, the chapter looks at the performance of a two counter-factual regional model distributions of support which have been considered as possible future payment models: flat rate of support across the whole Scotland, or two rates of entitlements, one for LFA land and one for non-LFA land.

Chapter 5 estimates a dynamic model of agricultural income determinants, where agricultural income is a function of the economic size of farms. The model is specified as an Error Correction Model (ECM), which provides a clear distinction between the short-run dynamics and the implied long-run income relationship. The results from the model will be used in the subsequent chapter to provide the basis for a regression-based decomposition of vertical mobility and an analysis of equilibrium inequality.

Chapter 6 looks at the dynamics of agricultural income inequality in Scotland in the period 1995/1996 – 2009/2010. The role of transitory shocks in levels of inequality is investigated using the Shorrocks (1978a) rigidity index which captures the concept of mobility as equalizer of longer-term incomes. Annual and multiyear changes in inequality are also decomposed into vertical and reranking mobility indices, following the approach of Jenkins and van Kerm (2006). These two measures correspond to concepts of mobility as individual income growth and positional movement, respectively. The measurement of vertical mobility indirectly provides a test of Gibrat's law of proportionate effect for farm income growth, and the robustness of this result will be investigated based on Jenkins and van Kerm's (2011) data manipulation techniques. Vertical mobility will be further decomposed in the manner of Allanson and Petrie (2013) using the ECM results from chapter 5; this will characterize the influence of inequalities in income determinants on the redistributive effect of expected income growth. Lastly, equilibrium, or chronic inequality, will be measured and decomposed using the results of long-run income relationship from the ECM in chapter 5; the difference between actual and equilibrium inequality in this context corresponds to the concept of mobility as income risk and may be compared to Shorrocks rigidity measure in that it quantifies the role of transitory shocks in inequality.

Chapter 7 will present the conclusions from the whole thesis. The main findings will be summarized in a condensed way and policy implications from these findings will be discussed, as well as the thesis' limitations and suggestions for further work.

2 The CAP and farm income support

2.1 Introduction

> "Farm income has lagged urban incomes for many decades, and the concerns over economically disadvantaged farmers has been behind the foundations of much of the agricultural support, in the context that equity is good and disparity is bad. This is pure income transfer argument which is becoming less and less tenable as the size of transfers increases and their distribution, linked to production, falls largely on big enterprises."
>
> (Moore, 1987, p. 5)

The above quote captures well the essence of farm income policy in Europe; what is underlying the policy and why it is a politically difficult issue. This chapter will look in more depth at the causes of and the European policy solutions for the farm income problem. In order to better understand the current shape of agricultural policy and the political situation surrounding it in Scotland and the EU, it is very important to look at the history of support for farmers in Europe, the evolution of CAP measures which address the farm income problem, and the political context and future policy changes.

The chapter starts with a description of historical perceptions of the farm income problem and the need for support in section 2.2.1. Section 2.2.2 talks about the origins and early development of the CAP, followed by a discussion of how the support evolved from market price measures to direct payments and how this gave it the opportunity of being targeted in section 2.2.3. Section 2.2.4 discusses the creation and structure of the SPS (Single Payment Scheme). In section 2.2.5 the latest reform of the CAP for the financial perspective of 2014-2020 is outlined, and the chapter is closed with conclusions section.

2.2 The policy developments

2.2.1 Historical perception of farm income problem and need for support

Support for farmers in Europe has a long-lived history, which dates back to the 19th century. Until then the agricultural sector had been doing well – growing population pushed agricultural prices up, which encouraged farmers to invest in new techniques and crops. The resulting increase in supply mitigated the rise in prices, creating better living conditions for the whole society. Around 1800 the Industrial Revolution started in Britain; its arrival was made possible by the welfare created by a flourishing agricultural sector. At that time, agricultural protection was not necessary. Quite on the contrary, food imports were welcomed with open arms as a measure to reduce the pressure of population growth on agricultural prices. Consequently, import tariffs were either reduced or banned by many European countries (Koning, 2006).

That situation changed in the late 19th century, when on one hand, developments in transport made imports cheaper and more competitive, and on the other hand, the new technological solutions resulted in cheaper fertilizers that increased domestic production. The situation of farmers was further deteriorated by a reduction in demand for their products. The invention of electricity, artificial fibers and internal combustion engines raised the demand for fossil fuels as an alternative energy source and undercut the demand for agricultural products (Koning, 2006). Overall, bigger supply was faced with a smaller demand, which put agricultural markets under pressure. Resulting overproduction and decrease in prices affected farmers' income position, leading to stagnation in some rural areas. These developments made farmers seek support from the state; their calls were often backed up by manufacturers, who worried that stagnation in agriculture would adversely affect the industry sector (Koning, 2006).

These events marked the beginning of the farming lobby at the national level in Europe. The initial goal of the lobby in various countries was to obtain protection from the government through favourable policies supporting agricultural production and farming incomes. Faced with the new situation, Western European countries started introducing import tariffs. The beginnings of agricultural protection in Europe were purely national. However, these measures were addressed at a global increase in production and they worked fine only as long as the country in question was a net importer. By raising import tariffs, the country protected its farmers, and if this added to global overproduction and further decreased world prices, the tariffs could be raised even higher (Koning, 2006). The situation was not that simple if the country produced more than it consumed. In such a case, in order to export the surpluses, a subsidy to the farmers was necessary to bridge the gap between domestic and world prices; this process is called *dumping* and it is a very costly policy, which becomes more expensive the more surplus production increases.

The 1920s and 30s saw a large fall in prices and curbed domestic demand, caused by the Great Depression. The number of countries with surpluses increased, and a need for supranational policy emerged. Individual countries introduced supply management measures, and these were soon linked to international trade agreements. First agreements for commodities like wheat, sugar, tea and rubber were established (Milward, 1994). This led to the creation of the General Agreement on Tariffs and Trade (GATT), the precursor of World Trade Organisation, in 1949.

The situation of European agriculture changed drastically with the start of World War II, a very influential event in the shaping of current agricultural policy. Shortages of inputs of production (in particular labour), the disruption of supplies, loss of land due to military activities, and general damages caused by military campaigns induced a reduction in supply and caused food shortages (Milward, 1994). The experience of the war period taught everyone a vital lesson about how important food security was and that no country should be overly dependant on food imports. Following that, the main focus of agricultural policy became increasing food production in order to gain self-sufficiency. The main mechanism used to achieve this goal was through improving income position of agricultural community and encouraging larger food production. As Hofreither noted, "one of the key internal incentives to achieve self-sufficiency was price guarantees for producers at levels above the international averages" (Hofreither, 2007, p. 2). This policy soon achieved its goal, and within a decade many Western European countries found themselves with agricultural surpluses in some products, like dairy, beef and wheat (*Ibid.*, 2007).

In spite of rising commodity prices, farming income still increased at a slower rate than in other sectors. It is widely recognized by economic theory and supported by empirical evidence that technological progress in the agricultural sector of a growing economy causes a fall in agricultural prices, which leads to a "secular decline in agricultural incomes" (Petrick, 2008, p. 247). Engel's law (Engel, 1857) states that price and income elasticities of demand for food are low. Therefore an increase in the wealth of population or reduction in prices of food will have limited effect on food consumption levels. Contrary to this, the richer the nation is, the higher the level of expenditure on industrial products. Consequently, economic growth makes incomes in the industrial sector grow faster than those in agriculture. Yet another reason behind the stagnating agricultural incomes is the fact that a large part of the benefit from raising agricultural prices gets dissipated to upstream and downstream sectors (Hofreither et al., 1996). In other words, large part of the increase in agricultural prices is captured by input owners and producers of processed food products. For all these reasons, the income position of the farming community was still worse than in other sectors.

The farming lobby, whose political power was fuelled by the focus on food security after World War II, kept pressuring the governments for income support (Milward, 1994). An important notion that started gaining significance in political discussion at the time was that of *justice* for farmers. Since farmers were not benefiting much from rising commodity prices or economic growth, they started to feel injustice towards their sector, which, in spite of losing importance in the share of employment and national production to the industrial one, still remained imperative in order to feed the constantly growing population. The paradigm of *justice* that started appearing in the political discourse meant that the farmers called for their fair share of income growth in Europe (Petrick, 2008). In particular, increasing costs of fuel and fertilizers made farmers demand compensation in the form of *parity prices*. This new concept would dominate the political scene for many years to come.

The above discussion brings up the notion of the farm income problem which has been behind the developments of agricultural policy. The income problem has three inter-related aspects: poverty, inequality and stability. On the one hand, farmers suffer from low incomes which might trap them in poverty and make them feel disadvantaged in comparison with workers in other sectors, and on the other hand, due to the nature of agricultural production and markets, these incomes are very variable with fluctuations from year to year (Hill, 1999). In this context, addressing the farm income problem by policy-makers means increasing farm incomes to eliminate the poverty among farmers and put them on parity with other sectors, as well as to create safety mechanism which help them deal with income fluctuations between the years.

The issue of farm income problem is connected with how to measure the farmers' well-being. Historically, the attention has been focused on current farming incomes. However, nowadays farming is most often one of the activities that rural households engage in, and therefore overall income of the household is a better indicator of its welfare than just the farming income. Furthermore, a meaningful comparison among farms, as well as between farm and non-farm households, calls for inclusion of a wealth measure (Hill, 2000). As Hill points out, wealth is important since it generates income in many ways, and what is more, it provides security and freedom to use resources, as well as generates economic and political power. It is often neglected, but wealth is a meaningful measure of the financial status of farms (Mishra et al., 2002); thus current incomes are only one dimension of the farm's well-being, where wealth also plays an important role. That being said, the focus of policy-makers remains largely on current incomes analysis of the farmers' well-being. In line with this, and the fact that current income statistics are more easily available, the majority of research on the redistributive performance of support and farmers' welfare concerns the current income distribution. It could be argued that such approach, aside from characterizing the well-being of farmers, allows to evaluate the profitability of farming.

2.2.2 Origins of the CAP and the early developments

Aside from justice for farmers, another important line of thought that emerged in the political discussion after World War II was the rising awareness of benefits from international cooperation (Petrick, 2008). With GATT already in place, the Organization for European Economic Co-operation (OEEC) was established in 1948, followed by the European Coal and Steel Community in 1951. Political leaders started to realize that further integration could bring more gains, and that it could be a potential solution to the agricultural policy problems. With this in mind, several meetings at international levels were organized to discuss cooperation. These steps would eventually lead to the signing of the Treaty of Rome. In order to pursue the idea of organization of common agricultural market in Europe, a *Special Committee* was established by the Consultative Assembly of the Council of Europe (Hofreither, 2007). The committee decided to employ the concept of a supranational authority for agriculture drafted in the so-called *Charpentier Plan* put forward by France. The plan called for control of production levels in the participating states, fixing European prices relative to production costs, and the elimination of trade barriers between Member States.

The initial series of meetings took place between 1952-1954. There was a disagreement between two conceptual sides; one, represented by France and the Netherlands, argued for strong supranational authority, and the other, led by Britain, opposed supranationalism. These negotiations not only failed to reach any agreement, but also served to display the crucial differences between ideas of individual countries. However, what became apparent after this round of talks was the fact that several countries shared a common vision of European integration, including a common agricultural market (Zobbe, 2001). These were the founding members of the European Coal and Steel Community: France, Germany, Italy, the Netherlands, Denmark and Luxembourg. At a conference in Mesina in 1955, the fundaments for the European Economic Community (EEC) were built. Agriculture was only one of many discussed topics, however *the Spark Report* published as an outcome of the conference made it clear that a common market excluding agriculture was unattainable (Fearne, 1997). As Mansholt (1963) points out, there were four main reasons why it was so important to include agricultural integration. First of all, since it was unrealistic to separate agricultural and industrial products, excluding agriculture was unachievable. Secondly, the agricultural sector was of great importance in the economies of the six countries and it constituted a large share of both imports and exports. In 1955, 26% of the working population in these six countries, or equivalent of 18 million people, were employed in agriculture (Harvey, 1982). Furthermore, the influence of the agricultural sector on the rest of the economy was significant because of the fluctuations in food prices, which also affect the price levels in other sectors. Finally, another important factor was the significance of structural adjustments in the agricultural sector for the rest of the economy.

Reaching an agreement about including agriculture in the common market creation was a positive outcome, but all the stakeholders were aware of how difficult designing the actual policy would be. However, the Treaty of Rome establishing the EEC was signed in 1957 and came into force on January 1st 1958. The Member States were keen to sign the treaty as soon as possible in order to ensure some stability and peace in Europe (Zobbe, 2001). Agriculture was mentioned in very broad terms, with more specific policy developments planned for the years to come.

The following is from the Treaty of Rome concerning the objectives of agricultural policy:

> "Article 39
>
> 1. The objectives of the common agricultural policy shall be:
>
> a) To increase agricultural productivity by promoting technical progress and by ensuring the rational development of agricultural production and the optimum utilization of the factors or production, in particular labour;
> b) Thus to ensure a fair standard of living for the agricultural community, in particular by increasing the individual earnings of persons engaged in agriculture;
> c) To stabilize markets;
> d) To assure the availability of supplies;
> e) To ensure that supplies reach consumers at reasonable prices."

(The Treaty of Rome, 1957, p. 16)

These broadly defined objectives addressed the two burning issues of agricultural policy at the time. First of all, the painful memory of World War II was still fresh and food security was firmly on everyone's agendas (Milward, 1994). The policy was meant to prevent a situation in which European citizens suffered from low food consumption (Zobbe, 2001). Lack of self-sufficiency was considered a serious political weakness, especially in view of the scarcity of foreign currency (Hoffmeyer, 1958). Secondly, the issue of income security for farmers was crucial. The agricultural lobby, which was by then firmly established, made sure to pressure the governments for their fair share of the welfare cake. Points b) and c) relate to the previously mentioned farm income problem; the policy was meant to address the poverty and inequality aspects by increasing earnings from agriculture and the stability aspect by stabilizing agricultural markets.

The real political discussion about the detailed shape of the policy took place after the treaty was already signed (Zobbe, 2001). In July 1958, delegates of the Member States met in Stresa, Italy, in order to discuss the detailed regulation of the CAP. As noted by Fearne (1997), the outcome of the conference can be summarized by five main points. Firstly, agriculture was to remain incorporated in the broad economic strategy of the common market. Secondly, the trade between Member States was to be shielded from external distortions. Thirdly, the structure of European agriculture was meant to be based on family farm units. Fourth, the market organization was to be based on price support, complemented by structural policy, in order to guarantee optimal employment of factors of production. Finally, the solution to farmers' income problem would be achieved through this combination of price support mechanism and structural adjustment measures.

The choice of price support as the main instrument of the policy was discussed by Zobbe (2001), who claims that it was the only logical solution from the perspective of the contemporaneous decision-makers. Understanding why market price support was chosen is fundamental to understanding the existing shape of the CAP, as this choice determined its path of development up until the current shape. As a consequence of the rush in signing the treaty, the agricultural policy had to be implemented through already existing domestic policies, and therefore allowed for less flexibility and innovation. All the Member States used market price support in one form or another (*Ibid*., 2001). France, Germany, Belgium and Luxembourg used market organization and government intervention to obtain higher prices for main commodities. In the Netherlands, the government intervention took place only to maintain price stability. Italy did not have an explicit price measure, but implicit policy existed nonetheless, with state control of all agricultural trade.

Another reason why price support was chosen was the budgetary consideration (Zobbe, 2001). When support to farmers is provided through higher level of prices, the consumers bear the burden of the policy. European consumers were already used to paying high prices for food products. What is more, the Member States had just recovered from the post-war depression and were entering a prosperous period of economic growth. It was expected that growth of wages would more than offset the rise in agricultural prices (Fennell, 1973). On the contrary, any type of direct aid that was paid out from the common pool, like for example deficiency payments, burdens the budget. Considering the significant size of agriculture in the GDP and employment in the 1960s, the choice of deficiency payments would be immensely expensive. This would most likely result in higher taxes, which could potentially slow down economic growth. Additional argument supporting price support were low transaction costs of such a policy compared with any payments coming from the European Community's budget. Given all these reasons, the policy makers decided to choose price support as the main instrument of the CAP.

In the period 1955-60, the share of agriculture in both national income and overall employment began to fall (Holfeither, 2007). By 1960, the share of working population employed in agriculture dropped to 21%, or 16 million people (Harvey, 1982). Considering the rising labour productivity in agriculture, it was a great opportunity to allow for movement of farm labour to other sectors. The European Commission pushed the issue, which caused violent opposition from European farmers. In particular, the farmers resented the idea of reduction of farm labour and agricultural land, as well as the notion of building European agriculture around large farming units (Tracy, 1976). The operation of the agricultural lobby got in the way of reform, pushing for the status quo. This is a crucial point, since from then on European agriculture suffered from an essential structural difficulty. Too many people have been employed in satisfying only moderately rising demand for food, and the agricultural units have not been efficient enough.

This ideological mistake seems obvious from today's perspective, however at the time it was harder to predict the long-term consequences of giving into the pressure from the farmers. Furthermore, policy-making was still largely shaped by the painful memory of food shortages during World War II and efficiency was less of an issue. The initial shape of the policy was seen as a short-term fix and the policy makers were aware of its shortcoming. However, as it turned out, the future development of the policy failed to escape the direction imposed by the initial short-term solutions (Hofreither, 2007). As Petrick points out:

> "the CAP is but one example of how ameliorative policies motivated in the beginning by genuine concerns for significant inequities eventually come to be seen as an entirely new variety of a profound political (and budgetary) problem".
>
> (Petrick, 2008, p. 247)

From thereon, the development of the policy is marked by surplus production and excessive spending, widely criticized by public opinion (*Ibid.,* 2008). The issues of farming income was not solved successfully either. In spite of all the support received, economic growth continued to widen the gap between industrial and agricultural incomes, clearly displaying the structural shortcomings of the policy. The European Commission tried to solve the problem with further attempts to put emphasis on structural adjustment in the sector; one example would be the 1968 proposal of Commissioner Sicco Mansholt, who came up with a vision of "modern agricultural production unit" (Tracy, 1993, p. 186). The concept called for a gradual removal of small farming units, aiming to form a more consolidated sector. However, the farming community, pushing for their idea of *justice*, firmly opposed the idea and made sure it was removed from the political agenda.

The pressure to reform market interventions as dominant form of support started increasing. In the light of widespread academic critique of price support, a new concept of direct income compensation emerged among agricultural economists. The first person to mention such a solution was Nash (1965), who already in early 1960s advocated withdrawal of support for agriculture, but he argued that some compensatory measure was necessary to ease the transition. Consequently, he proposed temporary direct payments that would neither influence the productive decisions of farmers nor induce to stay anyone who prefers to retire or find another occupation (Nash, 1965). That was the prototype of what later became the idea of decoupled direct payment. In the late 70s, this notion became hugely popular among the majority of agricultural economists (Petrick, 2008). It was believed that such payments, through their stabilizing effect on incomes, would reduce the incentives to increase production in the face of falling prices. Koester and Tangermann (1977) also advocated the idea of direct payments decoupled from production – farmers would receive it regardless of what and how much they produced, even if they stopped the production altogether.

As Petrick (2008) points out, farmers quickly recognized that such a scheme would be very transparent and the value of transfers to producers would be easy to calculate. This could make the general public question how legitimate the support was and would most likely induce arguments about distribution of the payments among farmers – which is exactly what happened when decoupled payments were introduced around 30 years later. Farmers perceived any attempts of reforms as a threat to farm incomes, which would have a detrimental effect on social equity between farming and industrial incomes, undermining the core principle of the CAP. Consequently, they firmly opposed any ideas of breaking the link between prices and incomes. As Germond (2011) observes, farmers have been used to protectionism since the 19th century, and CAP constituted only an extension to the pre-existing pattern of protection. As such, defending CAP was merely a continuation in the tradition of fighting for their privileges. At the time, the still very influential agricultural lobby managed to remove the idea of decoupling from political consideration. The decoupled direct payments had to wait a few more decades for its role in European agricultural policy.

The dysfunctionality of the CAP was exacerbated in the 70s and 80s. The price support kept stimulating production levels and the surpluses became a big problem of the European farming (Petrick, 2008). Furthermore, the burden of expanding expenditure was apparent, with over 70% of EU's budget spent on CAP (European Commission, 2011c). In the 1970s the influence of agricultural lobby, and COPA-COGECA especially, was undermined by the Commission who was increasingly worried about the scale of surpluses and long-term costs of financing CAP. Nevertheless, COPA-COGECA could still maintain influence and block reform attempts through cooperation with national governments and national lobby groups, which favoured the status quo (Germond, 2011). Consequently, after the failure of Mansholt's plan, the 70's were marked by stagnation of reform proposals. However, the policy's failures and resulting widespread criticism caused resurgence in reforms in the 80s. Production quotas for certain commodities, like milk, were introduced, and price support started being reduced.

Attempts to control surpluses through production quotas were not successful. The ineffectiveness of it can best be displayed by the example of milk quota introduced in 1984. Although the quota was somewhat successful at constraining the domestic production, the limit was set too high for domestic demand. Around 10% of surplus production still had to be sold on world markets. Since the EU prices were above the world level, dumping was not eliminated. What is more, the excess production pushed domestic prices downwards, so they were hardly above the minimum level in the EU. As a result, small dairy farmers continued to go out of business, although perhaps at a smaller rate than without the production control (Institute for Agriculture and Trade Policy, 2007).

Over time, the importance of agriculture for the whole economy significantly decreased – less people were employed in the sector, whose contribution to GDP also shrank. For example, the number of people employed in agriculture in West Germany fell from 7 million in 1950 to 2 million in 1989 (Petrick, 2008, p. 249). The size of average farm tripled, and farm households started enjoying higher average income levels. However, it must be pointed out that the increase in income was not caused by increase in profits from agriculture as much as by diversification of sources of income – most farm households started earning additional income through activities other than farming (Buckwell, 1997).

The budgetary pressure of the CAP made the national governments more willing to support reform, and to reduce the leverage of farming lobby, both at national level, as well as from COPA-COCEGA, who turned its lobbying efforts on Member States after its relationship with the Commission deteriorated in the 1970s (Germond, 2011). What is more, the CAP came under increasing pressure to comply with world trade regimes, particularly from GATT.

2.2.3 Switch towards direct payments and potential for targeting

In 1985 the European Commission published the *Green Paper* which officially acknowledged the fact that the whole society was concerned about rural regions, and for the first time addressed functions other than agriculture (Petrick, 2008). Most importantly, however, the paper for the first time officially recognised concerns over the redistributive aspects of agricultural policy, that is dealing effectively and systematically with income problems of small farms, and the use of direct income aids to complement the market price measures (European Commission, 1985).

As a result of both the internal and external pressures, some fundamental reforms to the structure of the CAP took place in 1992. The *MacSharry Reform*[1] reduced market price support and introduced compensatory direct payments, which included arable and headage payments[2]. They were not fully decoupled from production, and hence were later referred to as coupled direct payments (European Commission, 2011c). The switch to direct payments opened up the possibility of addressing the inequality concerns and targeting support (Commission of the European Communities, 1991). This was initially addressed by the idea of modulating the support (for example by introducing thresholds of arable area below which farmers were not required to set land aside) in order to redistribute the policy benefits towards smaller producers, however, this idea was later abandoned and the modulation measures were not incorporated in the reform (Allanson, 1993).

---

[1] Named after Commissioner Ray McSharry

[2] EU area payments meant that farmers could apply for payments for land on which cereals, oilseed or protein crop were cultivated. Two schemes were available: simplified one, where the farmers were not required to set any land aside, and it was not specific to any crop; or general one, crop-specific, with set-aside requirement. Quantity of land on which the payments could be made was limited on a Member State basis. EU headage payments included payments linked to production of bovine and ovine animals and payments aimed at reducing seasonal variation or extensification (Frandsen *et al.*, 2002)

Basing the payments on average regional yields meant that the policy was a step forward towards decoupling the support from individual farm production levels. Such solution pleased both farmers and agricultural economists were content – the former were financially compensated and the latter saw the reform as a shift towards a more liberal system (Petrick, 2008).

Although the 1992 reform was a significant move towards market reorientation, the fact that payments were linked to fixed areas and fixed number of animals still maintained rigidity in farmers' decisions, not allowing them to fully respond to market signals and realize their full production potential (European Commission, 2011c). Another step that pushed the change forward was *Agenda 2000* reform in 1999, which saw the price support even more reduced, together with an increase in direct payments; it was an extension and deepening of the 1992 reform. This was in large part a response to the continuing external pressure that WTO exerted on the EU in order to further reduce the trade-distorting impact of the support, but also increased the targeting potential of the policy.

In addition to that, the reform introduced a second pillar to the policy. From there on Pillar I was meant to address producers' support, while Pillar II was created to deal with rural development issues. A new *European Model of Agriculture*, addressing its multi-functionality, was established (Ackrill *et al.*, 2008). Rural development measures included funding for areas like human resources, processing and marketing, business investment or support for *Less-Favoured Areas*[3]. Besides addressing the multi-functionality, these measures also allowed to transfer money to producers in a form

[3] "In areas designated as "less-favoured", agricultural production or activity is more difficult because of natural handicaps, e.g. difficult climatic conditions, steep slopes in mountain areas, or low soil productivity in other less favoured areas" (European Commission, 2009a).

which was compatible with Green Box measures since they were justified on grounds other than income support. As such, Pillar II payments were not designed to address the farm income problem per se, but although this might not be their objective, ultimately they still serve as income support for farmers. In addition to funding from the CAP (around 10% of its budget), Member States could co-finance these measures with their own money (*Ibid.*, 2008).

2.2.4 The Single Payment Scheme

In 2002, during the mid-term review of the Agenda 2000 reform, Agriculture Commissioner Franz Fischler took his opportunity to outline proposals for further change. The new idea was driven mainly by continuing trade-related concerns (*Ibid.*, 2008). The old direct payments were to be replaced by the Single Payment Scheme (SPS), which, by being completely independent from current production levels, would be fully decoupled. What is more, their receipt would be based on the condition of complying with certain environmental and animal welfare standards – a new concept called *cross-compliance*. Creation of such payments would allow the EU to move a majority of its support from the Blue Box to the Green Box. Just as with the creation of Pillar II payments, this would strengthen EU's position for another round of WTO negotiations, the Doha Round, which began in 2001 (*Ibid.*, 2008). The full shape of the new reform was finalized in 2003. The new payment was called the *Single Farm Payment* (SFP) and was introduced in the Member States between 2005 and 2007.

In order to be disconnected from current level of production, the payments are based on past levels of payments received in the reference period 2000 - 2002. They are linked to land; farmers are given entitlements with a monetary per hectare value. These entitlements are only activated once matched with corresponding hectares of land, and they can be traded within the country or a region.

Member States could choose between two methods of implementation of the scheme, historic or regional. In the historic model of the SPS, entitlements are determined on an individual basis. Each farmer is given entitlements based on the payments received by him/her in 2000-2002, divided by the number of hectares farmed in that period. This model of implementation essentially maintains the production related distribution of payments from the past. The regional model, on the other hand, allows for somewhat more redistribution of payments amongst farmers in a given region. Payments received in the reference period are summed up for a given region, and then divided by the number of eligible hectares in that region in the year the SPS was introduced. Accordingly, each farmer in a given region receives the same per hectare rate. However, these would vary between regions and the better the quality of land, most likely the higher the rate. National governments could also opt for a hybrid model between the two, with the ratio staying constant or varying over time (static or dynamic version). The option of regional model of distribution allows for more redistribution of support and cutting the link between productivity (in the historic sense) and support level. In this context, a government which opts for the historic model of the SFP misses a potential opportunity of targeting the support to less productive farmers. The scheme had to be introduced between 1st of January 2005 and 1st of January 2007. Each country's budget for the scheme, the *National Ceiling* (NC), was determined by direct aids in the historic reference period (European Commission, 2011c).

Some Member States expressed concerns that full decoupling could cause abandonment of certain activities, for example beef production (Ackrill *et al*., 2008). Consequently, within certain limits, some of the post-1992 coupled payments could be kept. Furthermore, compulsory *modulation* was introduced. The term *modulation* in this context refers to top-slicing of the payments from Pillar I and using that money for Pillar II measures. Up until the 2003 change modulation was voluntary, but according to the new rules it became compulsory. Pillar I payments were capped at 3% in 2005, 4% in 2006 and 5% from 2007 onwards. Member States had a further choice of increasing modulation up to 10% to keep this money a national envelope for Pillar II payments.

Upon the accession of 10 new states in 2004, old Member States were faced with a difficult financial issue of how to split the budget. Since the old members were reluctant to finance the enlargement from the start, a compromise was reached where the accession states would start making EU budget contributions from the start, but would be phased into the CAP payments regime from 2007 onwards (Mrak and Rant, 2008). The new Member States joined CAP under the Simplified Area Payment Scheme (SAPS), which was a transitional scheme with a flat rate payment obtained by dividing the country's national envelope by its utilized agricultural area (European Commission, 2009b). The entitlements in the new Member States are in general a lot lower than in the pre-existing member countries. This marks the beginning of another conflict of national interests between the old and new Member States, where the former are more interested in maintaining the status quo, and new Member States stand to gain from any redistribution through a EU flat rate of SFP (but would benefit even more from any shifting of resources towards EU's structural and cohesion funds).

In 2008, a review of the decoupling reform took place. On the 20th of November, EU agricultural ministers agreed on the final outcome of the review called the 'Health Check'. A number of changes to the existing policy were accepted (European Commission, 2008). Set-aside requirement was removed. Modulation was increased – all payments above 5000 euros were supposed to be cut by 10% from 2012. Furthermore, all payments above 300 000 euros were meant to be reduced by further 4%. Remaining coupled support was removed, leaving only suckler cow, goat and sheep premia. In addition, the 'Health Check' allowed the Member States that chose the historic model of implementation to change it to the regional one; this has been driven by a widespread criticism of a model based on a reference period that became harder to justify as more time from the period passed by.

2.2.5 The CAP 2014-2020

2014 was the beginning of the new EU financial perspective, and hence new CAP budget, which required some decisions about the shape of the future CAP. The European Commission launched a wide-ranging debate about the new CAP reform, which brought about much reflection, discussion and negotiation. This eventually led to a set of legal proposals aimed at making the policy more effective in shaping a more competitive and sustainable agriculture in the EU. On the 26th of June 2013, an agreement on the shape of the reform has been reached between the Commission, the European Parliament and the Council; this was the first time in the history that the

European Parliament acted as a co-legislator with the Council. On the 20th of December 2013 the reform regulations were officially published. The details of the adaptation of the reform are to be decided at a national level in 2014 (European Commission, 2013b).

Following the path of the earlier reforms, this is the first time the whole CAP has been reviewed and it resulted in, as claimed by the European Commission, the biggest reform of the CAP yet. The Commission identified three long-term objectives for CAP, "viable food production, sustainable management of natural resources and climate action and balanced territorial development" (European Commission, 2013b, p.2), and stated that CAP instruments need to be adapted in order to meet these objectives. Funding for CAP will be frozen at its 2013 level, which will mean a decrease in real terms. The new CAP maintains the two pillars, but it increases the links between them. The reform is extensive; among other things it includes abolition of production quotas, enhancement of producers organisation (through financial incentives and legal framework) and closing the gap between science and farming through the Farm Advisory System. Detailed description of all the elements of the reform is beyond the scope of this chapter; for more details see European Commission (2013a) and Waterhouse (2013). However, the most important change, which will be described now in more detail, concerns the adjustments to the SPS.

The new direct payments are to be more targeted, but also more complicated. Only active farmers will be eligible; in Scotland the farmer needs to be active at the moment of application (May 2015) by meeting conditions of article 9[4]. The new payments are

[4] "No direct payments to farmers whose agricultural areas are mainly areas naturally in a state suitable for grazing or cultivation who do not carry out on those areas the minimum activity required by the Member State. […] No direct payments to claimants who operate airports, railways, waterworks, real estate, permanent sport and recreational grounds." (Waterhouse, 2013, p. 21)

very flexible in terms of budgeting and implementation, allowing the Member States to tailor the policy in line with national agricultural, environmental, cultural and socio-economics conditions. Depending on decisions, first pillar support will consist of the basic payment[5], the greening payment provided greening conditions are met[6] (30% deduction from the NC) and young farmer top-up for eligible farmers (2% deduction from the NC); these three components are compulsory for all Member States. There is also a mandatory deduction of up to 3% of National Reserve for future new entrants. In addition, some of the NC funding for Pillar 1 can be diverted towards optional schemes:

- up to 8% for voluntary coupled scheme (VCS) where it is important for economic, social or environmental reasons,
- up to 30% (20% in Scotland's case) for redistributive payments targeted towards small and medium size farms in order to provide more targeted support; it should be redistributed to farmers' first 30 hectares or up to the average farm size if it is higher than 30 ha,
- up to 10% for small farmer scheme (max of 1250 euros per farm) which facilitates their access to direct payments and reduces administrative burden,
- up to 5% for Pillar 1 Areas of Natural Constraint (ANC)[7].

Members States also have the option of transferring up to 15% of Pillar 1 funding towards Pillar 2. All these options mean that the share of funding allocated to different schemes may vary significantly throughout the EU.

[5] With simplified and more targeted cross-compliance
[6] In order to qualify for this part of the payment, farmers need to maintain permanent grassland and ecological focus areas, as well as to engage in crop diversification. Further greening of CAP takes place through spending at least 30% of each Rural Development programme budget in Pillar 2 on payments which benefit the environment and prevent climate change.
[7] Which would be separate and would not affect ANC/LFA payments under Rural Development in Pillar II.

A very important change to the direct payments is rebalancing of their value both between Members States and within Member States. The discrepancies between countries will be reduced through external convergence which consists of gradual adjustment towards a minimum national average direct payment per hectare across all countries by 2020. In terms of inequalities at national level, the historic model of entitlement values will now become obsolete and replaced by area-based payments. Member States can either introduce a flat rate equal to the regional average from the start (where entitlement is equal to regional budget divided by declared number of eligible hectares), or through internal convergence[8] gradually move towards flat rates by 2019.

Member States have further choice regarding whether the flat rate should be introduced for the whole country, or for regions, and how to divide the land between regions. The options most recently considered by the Scottish Government (Waterhouse, 2013) include:

- use of historic land types, with either 3 land type regions (Arable, Permanent Grass, Rough Grazing) or 2 land type regions (Arable + Permanent Grass, and Rough Grazing)
- LCA (Macaulay Land Capability for Agriculture) capability option, with 3 LCA regions (1-3.1, 3.2-5.3, 6.1-7.2) or 2 LCA regions (1-3.1, 3.2-7).

[8] This option can be executed by either setting the flat rate equal to regional average in 2019, or by the so called *Irish channel*, where payment entitlements which in 2019 are equal to less than 90% of the regional average have the gap to the average closed by one third, with no payment entitlement receiving less than 60% of regional average (SG presentation).

2.3 Conclusions

The farm income problem has three inter-related aspects: poverty, inequality and stability. In essence, farmers suffer from low incomes and feel disadvantaged in comparison with workers in other sectors, and what is more, the income flows from agriculture are very unstable in nature which causes feelings of insecurity among farmers.

Because of these factors, agricultural protection in Europe has a long-lived history, dating back in its modern from to the late 19th century. When European Economic Community was formed in the 1950's, the national measures of protection were united under the Common Agricultural Policy. Two of the main stated objectives in the original treaty were a fair standard of living for farmers through increasing earnings from agriculture and stability in agricultural markets. These objectives were initially met through pure market support measures, however, the shortcomings of such policy became apparent over time: market distortions and surpluses, budgetary pressure, trade concerns and international pressure for reform. What is more, the lack of structural policy measures meant that the issue of lower farming incomes was not successfully solved either. The process of reform was long and gradual, with strong opposition from the agricultural lobby.

In the 1990's, the MacSharry reform introduced coupled direct payments as a compensation for cuts in market price measures. Direct payments offered greater transparency in support distribution and a possibility of addressing the concerns over who gets the support, that is the redistributive issue. Another big step for the policy was the "decoupling" of support in 2005 with the introduction of the SFP. The option of choosing the regional model of implementation was another opportunity to target support by cutting the link between historic volumes of production and transfer levels. Scotland did not use that opportunity, and opted for the historic model in order to avoid the political cost of dissatisfaction from the potential losers of the regional model of distribution. The fact that the modulation measures were dropped from the McSharry reform and many governments opted for the historic model of distribution present missed opportunities and show that the targeting potential of the direct payments have not been fully realized.

The new CAP reform which obliges all the Member States to introduce the area-based rates of payments presents an opportunity to cut the link between productive capacity and transfer size, which makes the support harder and harder to justify based on equity and income support grounds. However, many Member States, like Scotland, will aim to limit the size of redistribution by introducing regional rates of support, in order to limit the political costs linked to the losers of the flat rate redistribution.

The research in this thesis, through empirical analysis, will assess the targeting performance of the direct payments under the SPS by measuring the redistributive effect of support, both under the regional model of distribution and with a counter-factual regional distribution. What is more, the role of agricultural policy will be implicitly investigated in a dynamic context, by looking at the mobility and stability of agricultural incomes in years 1995/1996 to 2009/2010. As such, the analysis aims to characterize the performance of agricultural policy in the context of dealing with the farm income problem: the incidence of low and unstable agricultural incomes. In line with the main focus of policy concern, the analysis will focus on the current income distribution, without taking into account the wealth aspect or the off-farm source of incomes of the agricultural households.

3 Capitalisation of the Single Farm Payment

3.1 Introduction

The central purpose of agricultural subsidies is to increase farmers‘ income. However, by raising the income from farming, the subsidies increase the returns from resources used in farming. Therefore aside from the first order effect of the subsidies, which is the increase of income from farming, the financial support causes second-order adjustments related to the supply and input ownership chains (Van Herck and Vranken, 2011). Accordingly, if the production inputs are not owned by the farmers and their prices increase, the farmers‘ benefit from income support is reduced. The degree to which the payments are successful at reaching the pockets of their intended beneficiaries is called transfer efficiency.

This issue if formally recognized as a significant problem in the design of agricultural policy. An influential study by the OECD (2003) concluded that only 20% of all prices and market support translated into net gain for farmers, whereas the rest got dissipated between the owners of factors of production (Ciaian *et al*., 2011).

The primary factors of production in farming are land, family labour and capital (Latruffe and le Moeul, 2009). Of these factors, land has been given the most attention because a substantial share of farmland in industrialized countries is rented and an increasing number of payments are tied to land. Accordingly, concern exists over the extent to which the payments affect the rental prices of farmland (Halmai and Elekes, 2006).

The process through which subsidies impact land values is called capitalization. Farmland values represent the present value of expected future returns from the land (Hendricks *et al*., 2012). Rental rates should therefore reflect the expected return from the land in the rental period. When agricultural support becomes part of the expected future returns from the land, it gets incorporated into land values and rental rates through capitalization (Ryan *et al*., 2001). In particular, area payments affect farmland demand, which together with inelastic land supply will cause the payments‘ capitalisation into higher rents or farmland values. Specifically, one theoretical prediction is that when the land supply is fixed, the whole subsidy will be captured by a higher rent (Ciaian *et al*. 2011). As a result, farmers lose and landowners benefit from capitalization of the support, in the short term via higher rental rates, and in the longer term through capitalization of future support into land values.

These effects, apart from causing misdistribution of benefits between farmers and landowners (to the extent that these two groups are not identical), negatively affect land mobility and structural change (Van Herck and Vranken, 2011). Specifically, new entrants into farming are faced with higher entry costs and existing farmers with higher expansion costs. As a consequence, the movement of land between less and more efficient farms will be smaller, which impairs structural adjustment and reduces the competitiveness of the sector (*Ibid.*, 2011). Furthermore, higher land values raise farmers‘ fixed costs and increase the risk of operating losses when the support is cut down or stopped all together (Ryan *et al.*, 2001) – an issue that is particularly concerning in the context of CAP reforms and attempts to substantially reduce the level of support or remove it all together.

The SFP is directly tied to land through the per hectare entitlements and the requirement of eligible land to activate them. This fact has caused concerns over the capitalization of the payment into land values and its effect on rental rates.

The objective of this chapter is to obtain an average rate of capitalisation of the SFP into farmland rents in Scotland using FAS data for production years 2005/2006 – 2009/2010. The motivation behind this is improving the assumption on the SFP passthrough used in the next chapter of the thesis in order to calculate the net value of agricultural transfers used in redistributive effect analysis. More specifically, the numerical result of the passthrough (1- capitalisation) will be used to multiply the gross value of the SFP transfers to tenant farmers in order to obtain the net values. Additionally, the estimate of capitalisation rate will illustrate the transfer efficiency of the SFP.

The chapter starts with a literature review in section 3.2; first the theoretical considerations of the influence of government payments on land values are presented, followed by a review of empirical findings. Section 3.3 starts with a discussion of the Scottish rental market to inform the subsequent model specification, then variables creation is described, followed by a discussion on estimation issues and the presentation of the empirical results. The chapter ends with a conclusion section.

3.2 Literature review

3.2.1 Theoretical considerations

Multiple studies have investigated the potential impact of different factors on the degree of support capitalization. One such factor is the nature of support payments (Patton *et al.*, 2008). Direct support payments can be either coupled or decoupled. A payment is coupled when it is somehow linked to the type and level of production, for example a payment per hectare planted or head of livestock. On the other hand, with a decoupled payment, the link between it and the level and type of production is cut, and in principle at least, such a payment should not affect production levels. As far as the impact of the rental rates goes, one theory predicts that it is inversely related to the impact on production decisions. Roberts *et al.* (2003) claims that since decoupled payments should not affect current production levels, they get fully capitalized into the land value. The counter-example of coupled payments helps to understand the mechanism. With coupled payments, the production levels are distorted – in order to get more subsidy, farmers produce more than they would have under a free market situation. The demand for inputs goes up, increasing their prices. At the same time, more output is produced therefore the output price falls. These secondary effects offset some of the influence of the payment on the rental rates. With decoupled payments, the secondary effects should not take place, since the production level remains the same. Consequently, the landowner can capture the full benefit of the payment by increasing the rental rate.

Although theoretically decoupled payments should not affect production decisions, there are several reasons why they still might do. Bhaskar and Beghin (2009) identified five such channels:

- the payments affect the risk faced by farmers, reducing the risk itself (insurance effect through a decrease in income variability thanks to the payment) or farmers' aversion to risk (under the assumption of DARA[9], the wealth effect from farmer's increased wealth caused by the payment should reduce the aversion to risk),
- the payments reduce credit constraints faced by farmers, either by improving farmers' credit worthiness through wealth effect, or allowing them to make their own savings and investments,
- the payments influence farmers' labour allocation decisions; specifically by increasing their wealth, the payments affect their labour-leisure allocation,
- the payments affect farmers' decisions through expectations about future policy payments,
- finally, authors point out to the actual influence of direct payments on land values, prices and rents as a source of impact on production decisions.

Bhaskar and Beghin (*Ibid.*) reviewed a broad range of papers that empirically test the influence of these channels on production decisions, and they concluded that in most cases, the effects on production do occur but they are small in magnitude, with the impact on land prices being the most significant one. All in all, the fact that decoupled payments are in reality not without impact on production decisions can imply that the theoretical prediction about their full capitalization into land prices might not necessarily apply (Patton *et al.*, 2008). What is more, the prediction of a full capitalization of a decoupled payment implies a longer time frame, with a longer period

[9] Decreasing Absolute Risk Aversion (Ross, 1981)

necessary for a full adjustment of rents. Full capitalization of a payment in a period of few years is unlikely.

The capitalization of an area-based decoupled payment can also be analysed using the framework of input subsidies; the link between the payment and land necessary to activate the entitlements suggests the payment could be seen as a subsidy to land. Latruffe and Le Mouël (2009) theoretically analysed the impact of a factor subsidy on farmland rental markets and prices and pointed out that the key players affecting the degree of the factors subsidies‘ impact are “the relative levels of supply price elasticities of inputs as well as the extent of input substitution possibilities in production” (*Ibid.*, 2009, p.12). Their conclusion was that a simple land subsidy unambiguously increases the rental price of land, a reduction in the *buying-in price* (the opportunity cost) of land and an increase in the quantity of land used. However, the degree of these effects is positively correlated with the substitution possibilities between land and the non-land factor of production.

In summary, area payments that are targeted on land stimulate demand for farmland and if this is combined with inelastic land supply, the payments will result in higher rental rates for farmland, creating leakages of subsidy money to landowners. In particular, with fixed land supply (or land supply elasticity equal to zero), the subsidy is expected to get fully capitalized into land rents (Van Herck and Vranken, 2011).

Another aspect that might affect the capitalization rate specifically for the SFP is the implementation model used to assign the entitlements and the ratio of entitlements to the eligible area. Kilian and Salhofer (2008) investigated the influence of the implementation model on the extent of payment capitalisation into land values; they developed a simple graphical model in order to analyse the market, assuming that with SFP a secondary market exists – that for SFP entitlements – which are tradable. The ratio of eligible hectares to entitlements is crucial. As long as there are more eligible hectares than entitlements, the payments will not get capitalized into land values. However, if there is excess demand for eligible hectares, the payment will affect land values, with different implementation models giving rise to different impacts. With the historic model, some of the payment will get capitalized, and the more homogenous the entitlements, the bigger the capitalization. In the extreme case of all payments being homogenous – which corresponds to the regional model – the prediction is that the whole payment will get fully capitalized.

Swinnen et al. (2009) discussed the impact of tradability of entitlements and concluded it matters in some conditions. Specifically, if the eligible area is bigger than the number of entitlements, there will be no capitalisation of the SFP into land values with full tradability of entitlements. However, the more constraints to trade there are, the larger is the extent of capitalisation. Low tradability reduces the incentive to sell entitlements because the potential sellers cannot get the desired price. In that case these farmers prefer to keep the entitlements and compete for land which then puts upward pressure on land prices. When the eligible area is smaller than the total number of entitlements, the larger is the degree of capitalisation of the SFP into land values, the lower will be the price for entitlements. In the extreme case of full capitalisation of the SFP, the market price of entitlements will be zero.

Ciaian *et al.* (2011) argued that the cost of cross-compliance is a factor that limits the extent of capitalization of the SFP into land values, because it is an additional financial burden on the farmer that imposes a constraint on farm activities. The costs of meeting cross-compliance requirements vary by farm, since it is determined by farms‘ production structures, available technology and natural endowment. Ciaian *et al*. believe that in the extreme case farmers might choose not to benefit from the SFP if the cost of cross-compliance is bigger than the benefits of the payment. According to the regulations, in order for a farm to be eligible for the SPS, the entire land cultivated needs to meet the cross-compliance requirements (even if only part of it is used to activate the payment) (EC, 2003). This means that the costs of cross-compliance are linked not to the entitlements but to the land, which reduces the profitability of the land, shifting the demand curve down and thus reducing the capitalization rate.

The length of policy implementation is another factor to consider. Van Herck and Vranken (2011) pointed out that if subsidies are only implemented for a fixed period of time, their capitalization might be limited. The SFP is a compensatory payment of temporary nature and it is commonly accepted that it will cease eventually, although the exact time frame of this is unknown. This knowledge might act as a limiting factor for the extent of payment capitalization into land values.

Last but not least, the structure of land market is an important factor affecting the capitalization rate (Ciaian *et al*., 2011; Van Herck and Vranken, 2011). Rural markets are often affected by various regulations and market imperfections, which influence how much the rental and land values can absorb subsidies (Ciaian *et al*., 2008). Ciaian and Swinnen (2009a) observed that for farms facing credit constraints the value of the subsidy can close the financial gap and allow for investment and production expansion, which implies higher input use, including land, and therefore exerts upward pressure on land rents. Land market regulations and institutions, on the other hand, might have a restricting effect on the adjustment of the rental rate and the possibility to capture some of the payment by landlords. Of particular importance are price restrictions imposed by the government and the duration of rental contracts which is determined both by formal legislation as well as informal institutions (Ciaian, Kancs and Swinnen, 2010)[10]. If a maximum price ceiling is imposed on the market, this limits the potential capitalization of the SFP. Similarly, *ceteris paribus*, the longer the length of rental contracts, the smaller the scope for landowners to capture the payment by adjusting the rental rate at least in the short-term.

3.2.2 Empirical literature review

There exists a vast literature investigating the impact of subsidies on rental rates[11] (Latruffe and Le Mouël, 2009). These studies vary according to the type of agricultural support investigated. Some consider aggregate support (Kirwan, 2005; Roberts *et al*., 2003; Shaik *et al*., 2005), some look at the effect of price support (Floyd, 1965) and others investigate specific payments (Patton *et al.*, 2008). Of particular interest for the purpose of this chapter is the literature that analyses the impact of direct payments on farmland rental values, especially that of direct decoupled payments paid out on an area basis. The majority of such work has been done in North America, with fewer studies

---

[10] See the discussion on farmland market structure in Scotland 3.3.1.

[11] Majority of research on the agricultural support capitalisation focuses on rental rates rather than farmland values. This is because more data is available on the former, and with rental rates less attention needs to be paid to factors related to non-agricultural use of land and urban pressure (unlike with land values which concern longer periods).

performed using European data. However, recently more literature on EU payments' influence on land has appeared due to increased policy interest in the topic (Van Herck and Vranken, 2011). The following section will briefly mention the most frequently cited North American papers and then focus on the results of the European studies.

Kirwan (2009) investigated the distribution of income from overall government subsidies in America using U.S. census data for years 1992-2002, and found that on average tenant farmers capture 75% of subsidies and landowners capture 25%. Using U.S. county data for 1996-2000, Lence and Mishra (2003) investigated the impact of government payments on farmland rents, controlling for spatial autocorrelation. They disaggregated the payments into four types: deficiency payments, market loss assistance programme payments, production flexibility contract payments and conservations reserve programme payments; the last two types are decoupled payments. Their findings indicate a marginal impact of payments ranging from 0.25 to 0.86 cents of additional rent for every dollar of payment. Roberts *et al.* (2003) employed 1992 and 1997 U.S. Agricultural Census data which compares information prior to and after decoupling; they found a capitalization rate of between 0.34 and 0.41 of a payment dollar. Both of these papers concluded that decoupled payments affect the land rents more than the coupled payments. That accords with the theory and is consistent with the assumption that other input suppliers manage to capture some of the subsidy from coupled payments by increasing prices. However, Janssen and Button (2004) as well as Lambert and Griffin (2004) found the opposite; their empirical results indicate that the effect of coupled payments was bigger. These few examples alone show that there is lack of empirical agreement on the capitalization rate of government payments, with results being very context-specific.

Moving onto European studies, Patton *et al.* (2008) investigated the effect of coupled and decoupled payments on farmland rents in Northern Ireland using the data from 1994 to 2002. Their estimates vary depending on the type of payment. They found that the coupled direct payments for the sheep sector were fully capitalised, whereas these for the beef sector were not. The estimate of the capitalization rate for the only decoupled payment before the introduction of the SFP (Less Favoured Area payment) equals 120%, but it was statistically insignificant.

Breustedt and Habermann (2010) investigated the impact of EU per-hectare payments for arable crop land, which are coupled to production, on the farmland rental rates in Germany using data from 2001. The novelty of their research is the use of general spatial model, which allowed them to account for geographical correlations between farms. Their findings suggest a capitalization rate of the payment of 38%, as well as 0.72 euro increase in rent for every extra euro paid in rent by a neighbouring farmer.

As as far as the capitalization of the SFP goes, Kilian *et al.* (2008) analysed its impact on land rents in the Bavaria region of Germany using municipal level data from 2005 (the year SFP was introduced there). Germany used a hybrid model of implementation, which allowed the authors to divide payments into their historic and regional components, and test earlier theoretical predictions about the influence of the implementation model on the capitalization rate (Kilian and Salhofer, 2008). Confirming earlier theoretical results, the regional component of the payment capitalized more than the historic one, with statistically significant coefficients of 0.41 and 0.35 respectively[12]. Another important conclusion of the study is that the

[12] Although authors did not mention any test of significance of this difference.

capitalization rate increased over time (following the introduction of the SFP), with between 15% and 19% of every euro of the payments being additionally transferred to the landowners in more recent contracts.

Ciaian and Kancs (2012) researched the effect of Simplified Area Payment Scheme (SAPS) on rental rates in new Member States[13]. SAPS is the version of the SFP introduced in new Member States, who did not receive any payments in the historic reference period of 2000-2002. Simplified Area Payments have uniform entitlements per region, therefore they are very similar to the regional model of SFP. Ciaian and Kancs used farm-level panel data for the years 2004 and 2005 and found that almost 20% of the payment values is lost by farmers due to higher rents. This result is roughly comparable with the findings of Van Herck and Vranken (2011), who also analysed the impact of SAPS payments on farm rental rates in the new Member States[14] and found it to be between 10% and 15%.

Another study of SFP capitalization was performed by Ciaian *et al*. (2011), who employed the generalized propensity score (GPS) matching approach to estimate the capitalisation of the SFP using Farm Accountancy Data Network data for years 2004 - 2007 for EU-15 countries[15]. Their estimate for the weighted average capitalization rate of the payment is 6%, and 7% for the UK alone. They note that the relatively low percentage compared to results from the US could be caused by the rigidity of rental markets in Europe. Ciaian *et al.* (2011) further stated that the relationship between land rents and SFP is non-linear and discontinuous because of the many factors that influence it, like cross-compliance costs, entitlements tradability or the SPS

[13] Bulgaria, Czech Republic, Estonia, Latvia, Lithuania, Hungary, Poland, Slovakia.
[14] Bulgaria, Czech Republic, Estonia, Latvia, Lithuania, Hungary, Poland, Romania, Slovakia.
[15] The first fifteen members prior to 2004 enlargement.

implementation model. They concluded that there is wide variation in capitalization rates for different SFP levels, as well as between Member States – varying between 0% and 58%, with the hectare value of SFP being one of the main factors influencing the capitalization rate within a member state.

3.3 Estimation of the Scottish rental function

The aim of this section is to estimate the degree of capitalisation of the SFP into land rents in Scotland. It begins with a description of the Scottish rental market to inform the subsequent specification of the empirical rent function, followed by model specification, presentation of data summary and variables, and discussion on the choice of estimator; it is concluded with the estimation results.

3.3.1 Scottish rental market

Table 3.1 shows the distribution of tenant farms by tenancy type, together with the percentage of farms that are tenanting for years 2005 – 2010. There are four main types of agricultural tenancy holdings recorded:

- Short Limited Duration Tenancy (between 1 and 5 years duration),
- Limited Duration Tenancy (for 10 or more years with specific end date),
- Small Landholders Act (SLA) (only found outside crofting counties),
- 91 Act holdings (Tenancy or Limited Partnership).

As can be seen, most tenancies are 91 Act tenancies and so the focus here will be on the provision of this type of tenancy. The Scottish legislation on agricultural holdings guarantees the 'Minimum Three Years Rent Review Cycle', which means that rents cannot be changed in a period smaller than 3 years, but if both sides are content with the rent, no review needs to take place (Scottish Government, 2013b). There is no minimum or maximum price control for agricultural rents in the UK (Swinnen *et al*., 2009).

Table 3.1 Summary of tenant contracts by type in Scotland, 2005-2010.

Tenancy type	2005	2006	2007	2008	2009	2010
Short Limited Duration Tenancy (SLDT)	285	316	344	431	442	447
Limited Duration Tenancy (LDT)	99	119	166	204	242	262
Small Landholders Act (SLA)	-	-	70	91	94	101
Total 91 Act Tenancy and LTD Partnership	7,172	7,049	6,804	6,546	6,399	6,216
of which:						
91 Act Tenancy	6,348	6,308	6,051	5,795	5,851	5,722
91 Act Ltd Partnership	824	740	753	750	548	494
All tenancies	7,555	7,484	7,384	7,272	7,177	7,026
Holding with tenancy agreements	7,470	7,385	7,202	7,096	7,010	6,841
Total Holdings in Scotland	51,136	51,361	51,365	51,489	52,034	52,314
Percentage of Holdings with Tenancy Agreements	14.6%	14.4%	14.0%	13.8%	13.5%	13.1%

Source: Scottish Government.

The most recent piece of legislation (for the period studied here) is Act 2003 which largely maintains the crucial rules introduced by Agricultural Acts in 1958 and 1983. The following provision specifies the *market value rule* that was initially introduced by the Agricultural Holdings (Scotland) Act 1958:

> “For the purposes of determining the rent payable (…) the Land Court shall have regard to the (…) current economic conditions in the relevant sector of agriculture (…) disregarding any distortions of rent due to scarcity of lets”
>
> Agricultural Holdings (Scotland) Act 2003

This indicates that the rent should simply be a function of the value of the land in agricultural use by the tenant, using comparative valuation and disregarding scarcity of lets.

In the event that the tenant and the landlord cannot agree on the rent, they can take the case to the Land Court. Of particular relevance to the current study is the Moonzie Farm case (*R W Morrison-Low v The* Executors of the Late T H Paterson) which concerned the disagreement between the landlord and the tenant in relation to how the SFP should be treated in the determination of rent. The tenant's case was that since the entitlements belong to the tenant, the flow of income from them should not be included in the rent review. The landlord's view was that this income should be treated as part of the gross output derived from the farm. The landlord used an analogy to the treatment of previous payments, like Arable Area Payments, Sheep Annual Premium or Suckler Cow Premium, whose values in the period 2000-2002 were used as a historic reference to determine the value of the replacement SFP. These subsidies were a result of tenant's occupation of the landlord's land, fixed equipment and improvements and were therefore taken into account in setting the earlier rents. Since these coupled subsidies are used to determine the value of SFP, the landlord believes that the contribution of his land should still play role and therefore current rental rates should include SFP's contribution (CKD Galbraith, 2010).

In its decision on the 2nd of June 2010, the Court sided with the tenant and agreed that the SFP is an income support to the farmer, not the farm, and therefore should not be treated as part of gross output of the farm. Nevertheless, the Court did decide that the tenant should pay an additional £9 per acre of the rent in respect of the SFP (with the farm's entitlement value of £233 per acre, that makes for 3.86% of the SFP value to be included in the rent per acre). This reflects the fact that "a prudent hypothetical tenant would expect to pay a rent which was sufficiently high enough to attract the landlord, acting reasonably, to let the land to him. The prudent tenant would, therefore, take account of the receipts which are available to him from the SFP as a result of his occupying the land” (CKD Galbraith, 2010).

Recognising the importance of this ruling for rent determination in the whole of Scotland, the Court observed:

> ‘’It is clear that the issue of SFP is of critical importance not only to this case but to the level of rents across the whole tenanted sector in Scotland. There can be little doubt that, if not all, then the vast majority of tenants who have negotiated rents since 2005 have been prepared to treat their income from this source as part of the farm income to be shared with the landlord as rent. Where SFP is included in a budget it is typically found to be at a level which makes it the dominant element in the ‘profit’ of the whole enterprise. If such payments are not to be included, there will inevitably be a significant fall in rents.’’
>
> (Scottish Land Court, 2010)

CKD Galbraith, the tenant’s representative in the case, inferred that it was the case that “the level of rents have not changed following the introduction of SFP which would confirm our view that tenants do not consider SFP to be an off-farm subsidy which is not taken into account when offering for land to rent” (CKD Galbraith, 2010). While it is very likely that the Moonzie case ruling will be of important consequence for the future rent review process in Scotland, it looks like up to date landlords have been treating the SFP simply as a continuation of previous coupled direct payments.

3.3.2 Model specification

According to economic theory, the economic rent of an asset should reflect the flow of income from that asset in the rental period (Ryan *et al*., 2001). The flow of income from agricultural land comes from two sources: market returns from the agricultural production and agricultural support.

The crucial assumption used in modelling how the rents are set in this study is that landowners use past information on market returns and subsidies to set the rental rates. Two points justify this assumption. Firstly, rents are not based on contemporaneous individual farm returns per se, since the rents for year *t* will be set before returns are realized, given the length of production cycle (in particular, for cropping farms, rents will be set in advance of when returns are known since it takes time to plant, grow and then harvest crops). Legislation in Scotland requires the landlords to take "current economic conditions in the relevant sector of agriculture" (Agricultural Holdings Act, 2003) into consideration when determining rental rates. It seems reasonable to assume that very recent market returns are a relevant source of knowledge for landlords. Secondly, Scottish rental market is dominated by long-term contracts and the rent reviews are at least three years apart given the periodic review mechanism; thus the rental adjustment is not instantaneous and any sudden changes in the profitability are not likely to be reflected in rents.

For subsidies, the past information is particularly useful in predicting current levels of support. The value of SFP is set based on past payments, with the value of entitlement per hectare and the number of entitlements not changing from one year to another (unless the farm purchases additional entitlements). The SFP is the dominant component of support from 2005 onwards, but also other types of support are quite predictable based on the past payments (examples include Less Favoured Area payments).

Taking all this into consideration, the econometric model used to analyse the rental rates in Scotland is defined as:

$$r_{it} = c + \sum_{s=1}^{3} \beta_s y_{is(t,q)} + \sum_{k=1}^{K} \alpha_k g_{ik(t,q)} + \sum_{1=l}^{L} \lambda_l x_{ilt} + u_{it} \tag{3.1}$$

where:

- r_{it} is a rental rate per hectare for farm *i* at time *t*,

- c is a constant,

- $y_{is(t,q)}$ is the average of market returns of type *s* per hectare for farm *i* in the *q* years before *t*, where the different types of returns *s* are cropping, livestock and dairy,

- $g_{ik(t,q)}$ is the average government subsidy of type *k* per hectare for farm *i* in the *q* years before *t*; the *K* types of subsidies are identified in the following section,

- x_{ilt} is additional explanatory variable *l;* the choice of variables is discussed in the following section,

- u_{it} is a disturbance term,

- β_s, α_k and λ_l are the regression coefficients.

Therefore the rental rate reflects the profitability from land that comes from two main sources, market returns and agricultural support, but the information on it is assumed to come from past realized profitability. Rental rate for a given period is a function of averaged lagged market returns and agricultural subsidies from the previous few years (so if q=3, rent per hectare in period t is regressed against the average of returns per hectare in t-1, t-2 and t-3). The specification is tested for different lag lengths to check the sensitivity of results.

The different types of market return variable are obtained by interacting the market return with shares of enterprise mix from different agricultural sectors. This separation of market return by sector is done in order to control for sector-specific heterogeneity; since different sectors have different fixed capital requirements, net returns may capitalize differently for the sectors. Patton *et al.* (2008) dealt with this issue by interacting the net return variable with dummy variables for the main sectors they identify: dairy, cattle and sheep, and other. This study goes one step further, and instead of interacting the net return variable with sectoral dummies, it interacts it with the main shares of farms' enterprise mix: cropping, dairy and livestock. This allows for more thorough disaggregation of market return, since when we only look at types, some of the farm's activity is ignored. For example, farms classified as dairy farms could be only majority dairy farms, with significant share of agricultural production coming from cropping or livestock. Splitting the market return by shares of agricultural production, instead of main classification types, allows taking all agricultural activity into consideration.

The model can be interpreted as a type of adaptive expectations model in terms of landowners expectations of support levels used to set the rents. It smoothly addresses the issue of mixed influence of pre-SFP coupled payments and decoupled SFP on rents in the proximity of the reform date. The dataset does not contain information on when the rent was reviewed last time for specific farms. This means it is impossible to determine precisely when the rental rate is renegotiated to include the SFP in the consideration of its value. For example rents observed in 2005/2006 could have been set anytime in the past 3 years, or even earlier (depending on the contract revision times), therefore it will presumably reflect the influence of both historic coupled payments and the SFP levels if it was set prior to the SPS introduction, but it is hard to disentangle the influence of the two. What is more, the conclusions of Moonzie Farm case imply that landlords have been treating the SFP simply as a continuation of previous coupled direct payments, which also highlights the importance of previous coupled payments in rent setting process. These mixed influences are addressed with the use of a moving average of past payments, with slow transition from coupled direct payments to SFP over the years.

3.3.3 Data summary and variables

The study uses micro-level weighted data from Farm Accounts Survey (FAS). For the purpose of rent determination analysis, data for the period 2002-2010 is used. Rents from 2006 (2005/06 production year) onwards are used, with the information on lags of market returns and subsidies coming from 2002 onwards. The sample is restricted to tenanted farms only, in order to simplify the analysis. If the sample included also farms with both owned and rented land, there would be issues of possible heterogeneity between the two types of land and uncertainty about which land is actually being rented, but it would be impossible to distinguish this from the dataset. After restricting the sample, there are around 100 observations each year. Table 3.2 shows the breakdown of sample in each year by farm type. It needs to be taken into account that the restriction to tenanted farms only might introduce some bias in the sample. However, the sample is then weighted with weights adjusted in a way that it still should to be representative of the overall populations.

Table 3.2 Breakdown of sample by farm types[16].

Number of farms in the sample:

Year	*All*	*Cereal*	*General Cropping*	*Dairy*	*Specialist Sheep*	*Specialist Cattle*	*Cattle & Sheep*	*Mixed*
2006	112	13	5	7	9	36	27	15
2007	109	12	7	6	6	39	24	15
2008	102	10	8	5	4	35	26	14
2009	104	14	6	5	6	33	21	19
2010	106	14	7	5	8	35	21	16

Here you recalculate the weights in a way that they are representative of the relevant populations so the farms are still representative of the populations

Rents, market returns and subsidies are expressed in per hectare terms, after being divided by farmed land (measured using total adjusted agricultural utilized area variable).

The information on rents is directly available in the dataset. The market return variable is calculated using farm gross margin information from the dataset. Farm gross margin is equal to farm total output minus variable expenditure costs (Defra, 2010). Market returns are calculated by further subtracting the value of direct payments, which are separately identified in the analysis. Market price support measures are incorporated in the market return variable. The market return variable is then interacted with main types of enterprise mix shares, which are calculated as ratios of livestock, cropping and dairy SGM to the overall SGM.

[16] Although there are 8 farm types in the FAS dataset, the subsequent chapter merged Cattle and Sheep Lowland into other types because not enough observations for this type are to perform meaningful analysis. Accordingly, the breakdown in this table is only in the 7 types used in chapter 4.

The direct payments separately identified in the regression are:

- the SFP,
- crop-related payments (prior to 2005 these include total crop subsidies value (like Arable Area Payments) and Environmentally Sensitive Area (ESA) grants, while from 2005 onwards only energy and protein crops schemes),
- breeding-livestock related payments (prior to 2005 these include Suckler Cow Premium (SCP), Sheep Annual Premium (SAP), Beef Special Premium (BSP), extensification premiums, Milk Outgoers Schemes, Milk Agrimoney Compensation, and Hill Livestock Compensatory Allowances; from 2005 it is only Scottish Ewe Scheme).

Additionally, other covariates are included in the analysis to control for potential unobserved heterogeneity and check the sensitivity of the key results to their inclusion. The type of data contained in FAS is focused on farms' agricultural production; as such, the information on farmer and farm characteristics is rather limited. This puts restrictions on the possible covariates which can be included in the model. In particular, there is no information on any non-agricultural pressure that could impact the value of the rents. This, however, is only a minor concern since when rents instead of land values are analysed, the impact of non-agricultural pressure is very minor. The covariates included are:

- dummy for Less Favoured Area (LFA) to control for the impact of differences in land quality on rent levels,
- ratio of family labour units to total labour units; this is to account for the fact that rent might increase with the share of family labour in overall labour due to

differences in productivity between family and hired labour (Ciaian and Kancs, 2012),

- ratio of total fixed assets to fixed assets plus total loans to account for farm's access to credit[17] (Ciaian and Kancs, *Ibid.*).

Table 3.3 shows the summary descriptives of the variables used in the estimation (all in per hectare terms). The value of cropping and livestock coupled payments is very small from 2005 onwards, as it was largely replaced by the SFP.

Table 3.3 Summary description of the variables

Variable	*Mean*	*Standard Deviation*
Per hectare:		
Rent	63.08	44.61
Single Farm Payment (from 2005 only)	236.46	107.86
Cropping payments		
pre-2005	41.95	53.75
from 2005	0.12	0.54
Livestock payments		
pre-2005	121.86	90.66
from 2005	2.06	8.22
Market return	394.10	251.33
Cropping market return	74.08	128.99
Livestock market return	87.38	91.40
Dairy market return	32.04	138.79
Control variables		
Family/total labour	0.66	0.29
Assets-to-liabilities	0.84	0.21
LFA farms	73.30%	

[17] When the variable is constructed that way, value of 1 means the farm has no loans, and the smaller the ratio, the more loans owned by the farm.

3.3.4 Choice of estimator

The model is estimated using pooled OLS. In order to justify this choice Table 3.4 shows the decomposition of the variation in the variables into between-farm and within-farm components. It can be seen that the majority of the variation in the dataset is between farms. There is not much change in the key variables over time for specific farms, and the majority of information therefore comes from the differences between farms. The lack of within variation suggests that using a fixed effects estimator might not be the best econometric strategy and that a pooled OLS approach will be preferable[18]. Furthermore, the type of agricultural production will to a large extent reflect the quality of natural resources on the farm, which in the context of rent setting constitute the main source of fixed effects. Thus the disaggregation of market return by enterprise mix shares controls for unobserved heterogeneity between the farms sufficiently to allow for the use of pooled OLS estimator.

Table 3.4 Within and between variation of the key variables

Variable	*Mean*	*Standard deviation*		
		Overall	*Between*	*Within*
Rent per ha	63.08	44.61	46.95	7.68
Market return per ha	394.10	251.33	223.82	113.79
Cropping market return per ha	74.08	128.99	133.59	23.63
Dairy market return per ha	32.04	138.79	130.21	14.90
Livestock market return per ha	87.38	91.40	92.99	45.07
Single farm payment per ha	236.46	107.86	109.80	38.90
Crop payments per ha				
From 2005	0.12	0.54	0.48	0.31
Pre-2005	41.95	53.75	57.81	6.47
Livestock payments per ha				
From 2005	2.06	8.22	4.08	7.27
Pre-2005	121.86	90.66	91.17	18.82

[18] This was indeed proved by the results from fixed effect estimation, which produced estimates that were neither significant nor sensible from theoretical point of view.

The type of data available in FAS does not allow controlling for spatial correlation in the estimation (see Breustedt and Habermann, 2011). This is because the information on the location of farms is not specific enough, since it is limited to a location in a 10 km grid while the farms are widely spread across the whole territory of Scotland.

Furthermore, any analysis that assumes a sudden shift in value between years prior to SFP and these afterwards, like general propensity score matching approach (Ciaian *et al*., 2011), is not feasible. The rent levels are going to be set for an unknown interval of few years around 2005, therefore the analysis must allow for a smooth transition between when and how the SFP is incorporated in the rent.

3.3.5 Results

Table 3.5 presents the first set of results, where the rent per hectare is modelled as a function of average lagged market return and government payments, with no additional covariates. In the first half of the table, the first column uses a maximum lag of two years, and the second and third columns use maximum lags of three and four years respectively, where each lag has an equal weight. The comparison across the different number of lags is done to check sensitivity of the results to the lag specification. Considering the 3-year contract review cycle, no specification with lags beyond 4 years are explored. Cluster robust standard errors are reported because of evidence of heteroscedasticity and autocorrelation problems in the error terms (see bottom of Table 3.4).

This is the most basic model, when no additional covariates are included. It can be seen that the results remain quite stable across different lag specifications. Specifically, the coefficient on the SFP is between 0.11 and 0.15, which indicates that between 11 and 15 pence of every pound received by the farmer through the SFP is passed on in the form of higher farmland rents. This means the capitalisation rate of SFP is between 11% and 15%, and hence the passthrough to the farmer is between 85% and 89%. The model with 4 years lags has the lowest Akaike Information Criterion (AIC) and the highest R-squared, and is therefore chosen as the best specification.

Table 3.5 Rent regression, comparison across different lag numbers and weights[19].

	Equal weights: 2 years lags	*Equal weights: 3 years lags*	*Equal weights: 4 years lags*	*Linearly decreasing weights: 2 years lags*	*Linearly decreasing weights: 3 years lags*	*Linearly decreasing weights: 4 years lags*
Subsidies						
SFP	**0.114*****	**0.130*****	**0.148*****	**0.118*****	**0.135*****	**0.152*****
	0.032	*0.035*	*0.039*	*0.033*	*0.036*	*0.039*
Crop payments	**0.474*****	**0.538*****	**0.570*****	**0.495*****	**0.589*****	**0.594*****
	0.076	*0.081*	*0.075*	*0.077*	*0.087*	*0.080*
Livestock payments	**0.034**	**0.035**	**0.041**	**0.039**	**0.038**	**0.053**
	0.044	*0.047*	*0.052*	*0.044*	*0.048*	*0.053*
Market return						
Cropping	**0.153*****	**0.151*****	**0.136*****	**0.151*****	**0.144*****	**0.137*****
	0.024	*0.024*	*0.026*	*0.024*	*0.023*	*0.023*
Livestock	**0.020**	**0.025**	**0.042**	**0.015**	**0.018**	**0.022**
	0.028	*0.029*	*0.042*	*0.028*	*0.034*	*0.034*
Dairy	**0.0742*****	**0.0820*****	**0.0783*****	**0.0722*****	**0.0777*****	**0.0814*****
	0.015	*0.016*	*0.019*	*0.015*	*0.016*	*0.017*
Constant	**9.882**	**6.495**	**2.943**	**10.080**	**7.065**	**2.986**
	7.482	*7.588*	*7.206*	*7.437*	*7.493*	*7.236*
R-squared	0.583	0.612	0.64	0.579	0.607	0.63
AIC	4428.8	3863.3	3291.8	4433.9	3869.2	3302.3
Observations	465	410	355	465	410	355

Wooldridge test for autocorrelation in panel data *Ho: No first-order autocorrelation*			*Breusch-Pagan / Cook-Weisberg test for heteroskedasticity* *Ho: Constant variance* *Variables: fitted values of dependent variable*		
2 years lags	3 years lags	4 years lags	2 years lags	3 years lags	4 years lags
F(1,96) = 15.270	F(1,90)=14.996	F(1, 77)=4.566	chi2(1) =21.90	chi2(1)=11.16	chi2(1)=2.81
Prob>F = 0.0002	Prob>F=0.0002	Prob>F=0.0358	Prob>chi2=0.0	Prob>chi2=0.0008	Prob>chi2=0.0938

To further check the sensitivity of the results, a regression with weighted averages of lags was also performed; these results are presented in the last three columns of Table

[19] Coefficients are in bold and standard errors are in small print under the estimates. Statistical significance at 1%, 5% and 10% are denoted respectively as ***, **, *.

3.5. With this specification recent information is given more importance; the most recent lag has the highest weight and the weights decrease linearly. It can be seen from the table that the results are only slightly affected if the lags are weighted linearly. In particular, the capitalization of the SFP remains in the range of 12% and 15%, showing good robustness, therefore this option is not pursued further. No non-linear lag modelling options were explored.

Table 3.6 Rent regression, comparison of models with additional covariates.

	Model A	*Model B*	*Model C*
Subsidies			
SFP	**0.148*****	**0.190*****	**0.139*****
	0.039	*0.047*	*0.038*
Crop payments	**0.570*****	**0.524*****	**0.504*****
	0.075	*0.076*	*0.080*
Livestock payments	**0.041**	**0.006**	**0.038**
	0.052	*0.056*	*0.050*
Market return			
Cropping	**0.136*****	**0.139*****	**0.118*****
	0.026	*0.025*	*0.027*
Livestock	**0.042**	**0.041**	**0.058**
	0.042	*0.042*	*0.043*
Dairy	**0.0783*****	**0.0761*****	**0.0724*****
	0.019	*0.019*	*0.018*
Year dummies			
2006	-	**18.380**	-
		10.050	
2007	-	**12.010**	-
		8.112	
2008	-	**7.706**	-
		5.479	
2009	-	**3.527**	-
		3.190	
Control variables			
LFA dummy	-	-	**-13.410**
			9.639
Family/total labour	-	-	**6.198**
			9.058
Assets-to-liabilities	-	-	**-20.450**
			13.660
Constant	**2.943**	**6.697**	**26.460**
	7.206	*9.695*	*18.080*
R-squared	0.640	0.645	0.658
AIC	3291.8	3295.2	3279.9
Observations	355	355	355

Table 3.6 shows how inclusion of additional covariates affects the SFP estimate by comparing results from three different models; the basic model with lags of 4 years (Model A) is re-estimated with time dummies (Model B) and with the earlier specified additional explanatory variables (Model C).

Model B uses year 2010 as the base year and includes a dummy variable for each year between 2006-2009. With a short time period like this, period-specific systematic shocks could be non-negligible (Patton *et al.,* 2008), therefore it is worthwhile to control for time effects and see how that affects the results. The direction and magnitude of most of the coefficients are not affected by the inclusion of time effects, and the only significant difference is a slight increase in the SFP coefficient – from 0.15 to 0.19. However, the time dummies coefficients are not only statistically insignificant individually, but Wald test failed to reject the null of no joint significance with P-value of 0.31.

Model C includes additional explanatory variables available from the dataset that could account for some differences in farms' performance and rent levels. Essentially, the inclusion of these covariates is used to check if there is any significant unobserved heterogeneity between farms that was not fully accounted for by the disaggregation of market return by activity type. The coefficients on the additional covariates are not statistically significant individually or jointly, with Wald test failing to reject the null of joint significance with P-value of 0.17. The remaining coefficients do not differ much compared to Model A. This robustness check supports the assumption that most of the heterogeneity between farms is already controlled for by the disaggregation of market return by activity type. In particular, the coefficient on the SFP is 0.139, thus the results indicate that the estimate of degree of capitalization of SFP is very stable across the different econometric specifications.

While the main focus of this econometric exercise was the coefficient on the SFP, it is worth noting that the estimates of capitalization rate for crop and livestock payments are also robust, with the coefficients on these payments being in the proximity of 0.5 and zero respectively across all model specifications[20]. The result of high capitalization rate for crop payments is in line with expectations since crop payments are more tied to land whereas headage payments are not, therefore it is easier for landlords to extract higher share of the former and hence the higher capitalisation rate.

3.4 Conclusions

The primary purpose of agricultural payments is to support farmers' income. However, secondary effects of the payments may lead to dissipation of the money to other owners of factors of agricultural production, most notably landlords in the case of tenanted land. This has been officially recognized as problematic for agricultural policy (OECD, 2003) and, consequently, an increasing number of studies have investigated this issue.

From 2005 onwards, the majority of agricultural support in Scotland has been paid out in the form of the SFP. While it is decoupled from production levels, it remains linked to land - through per hectare entitlements and a requirement to have a corresponding number of eligible hectares to activate these entitlements. This link with agricultural land causes concern over capitalization of the payment into farmland rents.

[20] Although the result for livestock payments is not statistically significant.

The degree by which rents and land values increase as a result of the support is important for several reasons. First and foremost, it results in inefficiency and misdistribution of benefits between the tenant farmer and landlord. Furthermore, the impact on land prices increases fixed costs and the risk of operating losses if the support is reduced or stopped all together. Finally, higher land values make expansion of successful famers and entry of new farmers harder, which impairs structural adjustment in the sector.

This chapter used FAS panel data to estimate the extent to which the SFP received by tenant farmers is passed on to landowners through higher rents using data for production years 2005/06 - 2009/10. The motivation behind this study was to improve the assumptions used in calculating net values of the SFP transfers while measuring the redistributive effect of agricultural policy in Scotland in the following chapter.

In order to estimate the capitalisation effect, rent per hectare was regressed against the main sources of income from farming land: market return from farming (disaggregated by agricultural activity types) and different sources of agricultural support. Of primary interest is the coefficient on the SFP, which indicates how much of each additional pound of payment per hectare is transmitted into higher rents. In modelling the process of setting rents in Scotland it was assumed that landlords use information on past market returns and payments to estimate the profitability of agricultural land in order to set the rental rates. This is consistent with the reality of the rent-setting process as governed by legislation in Scotland.

The average transfer efficiency of the SFP remains in the range of between 81% and

89% across a wide range of alternative econometric specifications. The robustness is tested by different approaches to modelling the past information, as well as inclusion of time fixed effects and other covariates, and the estimate on the SFP always stays within this narrow range.

The study concludes that in the production years 2005/06-2009/10 the increase in agricultural rents as a result of the SFP is between 11 and 19 pence for every pound paid to the tenant farmers. That means the transfer efficiency of the payment is between 81% and 89%. Such a passthrough rate is relatively high compared to theoretical predictions about the transfer efficiency of decoupled payments which suggested that the capitalization rate might reach up to 100%. Comparing it to other available estimates of SFP capitalisation, it is lower than the 35% suggested by Kilian et al. (2008), but larger than the average estimate of 6% as reported by Ciaian *et al*. (2011). It is in fact more in line with the results of Ciaian and Kancs (2012) and Van Herck and Vranken (2011) who analysed the capitalisation rate of the SAPS and obtained estimates of 20% and between 10% and 15% respectively. The implied capitalisation rate in Scotland is higher than the suggestion of Land Court that landlord should capture around 4% of the SFP value in higher rents.

Given that the results from different specifications fall within a narrow range, the middle of this range is chosen to calculate passthrough of the SFP for tenant farmers in the following chapter – that is the passthrough rate of 85%. While this figure is estimated based on tenanted farms sample only, it will be used to calculate the passthrough of the SFP also for farmers who rent only part of their land, for the part of the SFP tied to the rented share of land.

4 Redistributive effect

4.1 Introduction

Among the multiplicity of objectives that the CAP is required to address nowadays, ensuring a fair standard of living for the farming community seems somewhat lost and poorly defined. The current distribution of support reflects many different goals, like environmental sustainability or rural development. Nevertheless, the income support aspect was one of the starting objectives behind CAP, and the biggest part of the current support is distributed through the SFP, which is a continuation of compensating farmers for cuts in market price measures, and therefore constitutes an income support measure.
The goals of ensuring a fair standard of living for the farming community and reducing income disparities depend on the distribution of support across farms. In this context, assessing the redistributive performance of agricultural policy is of great importance, and is in accordance with the OECD (1998), which points to equity and targeting as operational criteria for the evaluation of agricultural policy. Furthermore, concerns about the inequitable distribution of agricultural income support have been expressed by the European Commission (1991, 2002).

The purpose of this chapter is to analyse the redistributive effect of agricultural support in Scotland in production years 2005/2006 to 2009/2010. The majority of the support in that period comes from the SPS implemented using the historic model under the financial framework of the CAP that came into effect in 2005. This task will be performed using a formal decomposition of the redistributive effect using methodology based on Allanson (2008) which allows us to see how the vertical effect of support, associated with progressivity, is reduced by the incidence of different types of horizontal inequality (HI): within and between farm types classical HI and reranking. The measurement of redistributive effects is useful for the design of agricultural support policy by indicating ways in which it might be made more effective as a tool for redistribution of income.

In addition to the analysis of the current situation, results for two hypothetical distributions under variations of the regional implementation model are generated in order to allow for comparison of redistributive performance between the models. Such an exercise is useful in the context of the new reform of the CAP where the historic model of distribution will be replaced by area-based flat payments in all Member States.

Section 4.2 provides a literature review of studies on redistributive performance of support. This is followed by a methodology section which starts with the description of inequality measure and concepts of vertical and horizontal inequality. Next is a discussion of relevant literature that contributed to the chosen methodology, the formal redistributive effect decomposition method and the estimation procedures. Section 4.4 starts with a discussion of variables and policy scenarios and ends with a presentation of empirical results. Section 4.5 contains conclusions of the chapter.

4.2 Literature review

A variety of studies have been performed on the broad concept of distributional performance of the CAP, focusing on its different aspects and using a multiplicity of methods. A large part of this literature investigates the efficiency aspect of transfers (see chapter 3). Research undertaken on the equity of transfers has largely focused on its vertical aspect. Thus most of the studies analyse the distribution of support between farms with different levels of income, as well as the dispersion of funds between Member States of the EU.

Schmid *et al*. (2006) used budgetary statistics on the allocation of direct payments to obtain distribution indicators, including Lorenz curves and Gini coefficients, which are used to analyse the distribution of payments across farms in the EU-15. These authors reached the conclusion that the payments are not distributed equally, with the majority of them going to a small number of large farms in a few Member States. Furthermore, they looked into the distributional consequences on farm household incomes in Austria using the Farm Accountancy Data Network (FADN). The measure they employed was mean absolute difference (MAD)[21], which is robust even with negative incomes. The measure is calculated for market income, and market income plus one of the following: direct payments from first pillar, LFA payments and agri-environmental payments. The conclusions reached in the study indicate that CAP instruments are proportional to farm size. In particular, agri-environmental payments and direct payments favour bigger farms, which also exhibit economies of scale, and therefore benefit more in both ways.

[21] MAD = $\left\{ \frac{1}{n^2} \sum_{i=1}^{n} \sum_{j=1}^{n} \left| x_i - x_j \right| \right\}$, x denotes the income of individual i (i = 1,...,n); x_i and x_j are the i'th and j'th elements in the sample

LFA payments have a weakly equalizing effect, and overall the support has only a slightly equalizing impact on the distribution of income.

Von Witzke and Noleppa (2007) employed a decomposition of the Gini coefficient into the components due to various income sources. The Gini coefficient can be written as a sum of concentration coefficients which measure how much income from each source k is transferred across population ranked with respect to the level of income received multiplied by the relative share of income from that component to the overall income; $G = \sum_{k=1}^{K} \frac{\mu_k}{\mu} C_k$ where $C_k = 2\operatorname{cov}(y_k, F) / \mu_k$. Following Rao (1969), the relative share of inequality due to component k is then $\frac{\mu_k}{\mu} C_k$. The authors separated farm income into direct payment and market income components (where market income incorporated market support measures). The analysis was done using two samples from the German Federal Ministry of Food, Agriculture and Consumer Protection data; one of 11,756 family farms from 2005 and one of 481 large incorporated farms from 2004/2005. The results showed that direct payments contribute significantly to farm income inequality in Germany. Around a third of the observed inequality between family farms and roughly two thirds between the large incorporated farms is attributed to direct payments.

Keeney (2000) also used the decomposition of the Gini coefficient by income sources, but she observed that while it is tempting to assume $\frac{\mu_k}{\mu} C_k$ is the relative contribution of source k to inequality, the decomposition components lack an implicit reference distribution and should therefore not be interpreted as a measure of the contribution towards income inequality. Furthermore, the summary statistics of the decomposition formula should not be used to quantify the income sources contributions without returning to the micro data. Accordingly, the contribution of each income source to total inequality was evaluated by calculating a reference distribution Gini coefficient with each income component set equal to zero in turn but with income units maintaining their observed rank in the overall income distribution. Additionally, following Lerman and Yitzhaki (1985), Keeney analysed how a marginal increase in one of the components impact the overall inequality. She further looked at the contributions of changes in the components of income over time to a change in overall inequality, separating support into direct payments and market-based support. The data used in the study came from the Irish National Farm Surveys (NFS) for years 1992 and 1996 (since these two years correspond to the last pre-McSharry reform calendar year and first post-McSharry calendar year). The conclusions reached indicate that direct payments introduced by the MacSharry reform led to a more equal distribution of farm income in Ireland. The paper found that relative inequality dropped between 1992 and 1996 by 13%. In terms of the distribution of direct payments, it is skewed towards richer farms, with farms in bottom three deciles of the income distribution, which are drastically dependant on the support, benefiting only from 13.9 % of the overall value of direct payments. While the DPs are unequally distributed, they are less unequally distributed than overall income, with farms below the median income earning 13.8% of income while receiving a bit over 29% of direct payments. This statistic indicates a slightly redistributive effect of the direct payments. As far as the change in inequality goes, DPs were also shown to have reduced inequality whereas market support increased it.

Yet another method to compare different policy scenarios was used by Rocchi *et al.* (2005), who employed an amended social accounting matrix (SAM) technique to disaggregate the institutional sectors into agricultural and non-agricultural households. This modified framework was then used to perform two types of analyses: a multiplier analysis in order to look into the distributive structure of agriculture in Italy, and a simulation of the distributive effects of alternative agricultural policy solutions (with different degrees of decoupling). The authors concluded that as far as reduction of inequality among farmers goes, decoupled payments perform better than market price support.

Lastly, the OECD (Moreddu, 2011) carried out an extensive study in the OECD Network for Farm Level Analysis that investigated the distribution of agricultural income and support in Canada, the United States and the EU. The paper found that 25% of largest farms produce 45-85% of gross agricultural output and also receive between 35% and 75% of all the support. These farms represent between 50% and 75% of all income, and their average income is substantially above the average income for all farms. In terms of support distribution, market support is closely linked to production, so its distribution is less equal than that of payments. Overall, while the distribution of support is unequal and skewed towards larger farms with higher average income, subsidies, and particularly payments, constitute a higher share of gross receipts for smaller farms, making the support distribution slightly less unequal and serving to reduce inequality. In terms of differences between farm types, in many countries the support is concentrated on a few farm types, like cropping or dairy. Differences in average rates of support and income level are bigger by farm type than by farm size. This being said, in many cases support reduces the inequality between farms types, especially in EU Member States where high earning farms producing commodities like poultry, fruit or vegetables receive less support than low earning grazing livestock farms, particularly in less-favoured areas.

The findings of the OECD report are quite informative, however the methodology behind it is rather simplistic. In order to analyse the distribution of support, differences in average support by farm type, size and region were compared. The distribution of support was also compared to that of gross agricultural output and income. Relative Gini coefficients and Lorenz curves were calculated for the different measures. It is pointed out that in the study the relationship between support and income is “a purely static and accounting one” (*Ibid.,* p. 10). The author recognized that the transfer efficiency of support is less than one, but the report did not control for this.

As informative as all these studies are, they fail to provide an explicit picture of the redistributive performance of a specific policy scenario. In particular, the potential impact of horizontal inequalities on the redistributive performance of support has been largely neglected as an issue. This is addressed by Allanson (2008) who, in the spirit of Kakwani (1984) and Aronson *et al*. (1994), develops an innovative framework of redistributive effect decomposition. This methodology is then used to analyse redistributive performance of agricultural policy in Scotland and Italy (Allanson, 2008; Allanson and Rocchi, 2008). However, both analyses are performed on Scottish data for the period prior to 2005, that is before the introduction of the SPS.

4.3 Methodology

This chapter will analyse the redistributive effect of agricultural support in Scotland as a tool to assess the equity aspect of the policy using the methodology of Allanson (2008; Allanson and Rocchi, 2008). Adopting the standard change-in-inequality approach, for the purpose of agricultural support the redistributive effect can be defined as "the difference between the inequality of farm incomes without and with the transfers accruing from the provision of support" (Allanson, 2008, p.1).

This section will start with a description of the inequality measure and the notions of vertical and horizontal inequality, and is followed by a discussion of the relevant literature on which the methodology is based, before moving on to the presentation of the redistributive effect decomposition methodology. The section is concluded with an explanation of estimation procedures.

4.3.1 Choice of inequality measure

The key issue in measuring the redistributive effect is the choice of inequality measure. What follows is a brief discussion of the most common inequality measures, which vary with regards to the sensitivity at different places in the income distribution, concluded with the choice of index for the subsequent analysis.

One possible choice of inequality measures is the Generalised Entropy class of indices, which have the general formula:

$$GE(\alpha) = \frac{1}{\alpha^2 - \alpha}\left[\frac{1}{n}\sum_{i=1}^{n}\left(\frac{y_i}{\bar{y}}\right)^{\alpha} - 1\right] \tag{4.1}$$

where y_i is the income of individual i, n is the number of individuals in the sample, and $\bar{y}$ is the arithmetic mean of incomes across the n individuals. The value of GE ranges from 0 to infinity, where 0 represents an equal distribution of income and higher values correspond to higher levels of inequality. Of crucial importance is the parameter α which represents the weight placed on distances between incomes at different points in the income distribution, and can take any real value. Lower values of α mean that GE is more sensitive to changes in the lower end of the distributions, whereas higher values of α mean it is more sensitive to changes in the upper tail. The most common values used are 0,1 and 2, where 1 gives equal weight across the distribution but 0 and 2 are skewed towards the lower and upper tails accordingly. GE measures with parameters of 0 and 1 become two of Theil's (1967) measures of inequality, that is the mean log of deviation and Theil index, respectively:

$$GE(0) = \frac{1}{n}\sum_{i=1}^{n}\log\frac{\bar{y}}{y_i} \tag{4.2}$$

$$GE(1) = \frac{1}{n}\sum_{i=1}^{n}\frac{\bar{y}}{y_i}\log\frac{\bar{y}}{y_i} \tag{4.3}$$

While with α=2, the GE measure becomes half the squared coefficient of variation:

$$CV = \frac{1}{\bar{y}}\left[\frac{1}{n}\sum_{i=1}^{n}(y_i - \bar{y})^2\right]^{1/2} \tag{4.4}$$

Moving on, the Atkinson class of measures has the general formula:

$$A_{\varepsilon} = 1 - \left[\frac{1}{n}\sum_{i=1}^{n}\left[\frac{y_i}{\bar{y}}\right]^{1-\varepsilon}\right]^{1/(1-\varepsilon)} \tag{4.5}$$

where ε is an inequality aversion parameter ranging between 0 and infinity. The higher the value of ε, the more society is concerned with inequality (Atkinson, 1970). The Atkinson class of measures can take on values between 0 and 1, where 0 corresponds to no inequality. If we set $\alpha = 1 - \varepsilon$, the GE class becomes equivalent to the Atkinson class of measures, for values of $\alpha < 1$ (Cowell, 1995).

The most commonly used measure is the Gini coefficient, an area measure related to the Lorenz curve. The Lorenz curve is a graph that represents the equality of income distribution; it shows the cumulative proportion of the population in the ascending order of income units plotted against the cumulative proportion of total income received by the given income units (Lambert, 2001). In the case of perfect equality in the income distribution Lorenz curve coincides with the 45° line, otherwise it lies below it. The Gini coefficient "measures the area between the Lorenz curve and the 45° line as a fraction of the total area under the 45° line" (Lambert, 2001, p. 27). It can be defined as:

$$G = \frac{1}{2n^2\overline{y}}\sum_{i=1}^{n}\sum_{j=1}^{n}\left|y_i - y_j\right| \tag{4.6}$$

and it takes value between 0 and 1 where 0 corresponds to no inequality.

While Gini coefficient is not decomposable of the sub-vectors of incomes overlap (Litchfield, 1999), it is useful for redistributive purposes and rank dependant measures. In particular, its relationship with the concentration index makes it very popular in measuring the redistributive effect. Extended Gini coefficient with different degree of inequality aversion could also be used. However, the most standard approached is to use the regular Gini coefficient for the purposes of analysing the redistributive effect.

The redistributive effect can be seen as the magnitude of the shift of the Lorenz curve line between pre-support and post-support incomes. Accordingly, the redistributive effect can be written as $R = G_X - G_Y$, where G_x and G_Y are the Gini coefficients of pre-support and post-support income, respectively.

However, for the purpose of this study the choice of inequality measure is constrained since agricultural incomes can be negative, and many standard measures are not defined in such a case or result in ill-behaved measures if the income is negative on average (Amiel *et al.* 1996). Specifically, the Gini coefficient is inappropriate since its sign depends on the sign of average income. In particular, if the average pre-transfer income is negative and the average post-transfer income is positive (which is often the case with agricultural support), R will be non-positive, regardless of the effect on inequality (Allanson, 2006). To solve this problem, some measure of absolute inequality can be used and the absolute Gini index is chosen. It can be defined as "half the average absolute difference between all distinct pairs of incomes in the population" (Allanson, 2008, p. 4):

$$A = \left\{ \frac{1}{2n(n-1)} \sum_{i=1}^{N} \sum_{j=1}^{N} \left| y_i - y_j \right| \right\} \qquad (4.7)$$

Thus, following Allanson (*Ibid.*), with this choice of inequality measure, the redistributive effect is redefined as the difference between absolute Gini indices of the pre-support income A_x and post-support income A_y: $R = A_X - A_Y$.

The useful property of absolute measures is the fact that they are not affected by equal absolute changes to all incomes. This means that an equal flat-rate payment to all farmers will be distributionally neutral, whereas with relative measure distributional neutrality is achieved through a payment which is the same proportion of everyone's income – meaning that richer farmers receive more as their incomes are bigger. As Allanson (2008) points out, the notion of distributional neutrality under the absolute measure of inequality seems more in accordance with what is perceived as just by society in the context of agricultural policy.

Additionally, the fact that absolute Gini coefficient is equal to the product of the ordinary Gini coefficient G and the average income y implies a normative interpretation of the redistributive effect with reference to Sen's (1973) welfare measure $W=y(1-G)=y-A$. If W_Y is the welfare in the post-transfer distribution and W_E is the welfare with a hypothetical flat rate payments which are equal in total value to the actual support, $W_Y - W_E = (\bar{y} - A_y) - (\bar{y} - A_E) = A_E - A_Y = R$ since $A_E=A_X$ by definition. This can be interpreted as the monetary value of redistributive effects of the policy on an individual farm basis. In other words, R will represent how much or less money each farmer would have to be given under distributionally neutral policy of flat rate payments in order to obtain welfare level equal to that with the actual support.

4.3.2 Horizontal and vertical inequality

Along the lines of Kakwani (1984), the redistributive effect can be decomposed into horizontal and vertical components, providing a quantitative framework for the analysis of the contributions these two aspects make towards the redistributive effect of policy. This provides a better insight into the redistributive properties of the subsidies by showing the magnitude of the progressivity of transfers and how it is offset by various sources of HI. Such decomposition is informative for improving targeting of the support and the design of policy.

At this stage, some explanation of the notions of horizontal and vertical equity is needed. Horizontal equity, in its classical version, refers to equal treatment of income equals (Musgrave, 1959) and ensures that there is no discrimination on grounds other than income, like race, gender, or, in the context of farms, type of agricultural activity. Two main concepts support this principle (Duclos *et al.*, 2003). Firstly, the presence of horizontal inequity (HI) undermines the progressive redistribution of income; therefore aversion towards it is simply a corollary of general aversion towards any type of inequality. Secondly, a system in which comparable individuals are treated differently can have negative effects on welfare and social order by causing feelings of resentment, injustice and insecurity.

Vertical equity, on the other hand, requires that units with different incomes should be treated differently - in other words it calls for reducing wealth gaps. Vertical equity is often said to be less ethically sound than horizontal equity, since “depending on the retained specification of distributive fairness, the requirements of vertical justice can vary considerably, while the principle of horizontal equity remains essentially invariant” (Duclos *et al.*, 2003, p. 4). Nevertheless, it remains widely believed that a fiscal system should conform to both notions of equality (Kakwani, 1984). Formal decomposition of the redistributive effect helps to verify if this is actually the case.

Another notion that needs to be mentioned in relation to income redistribution is reranking. Reranking can be defined as the change in the ranking of incomes that occurs in the process of transition from pre-transfer to post-transfer distribution. Reranking is a negative outcome of any fiscal system. If it is systematic, it creates income traps – situations where it can be more beneficial to be poorer to begin with as the fiscal system makes poorer individuals better off after the transfers. Atkinson (1980) and Plotnick (1981) almost simultaneously uncovered this effect, which they measured as the difference between the Gini coefficient and concentration coefficient[22] of the post-support income ranked by pre-support incomes, $G_Y - C_Y$ (Lambert, 2001, p. 40).

Reranking has been identified with horizontal equity, given that absence of the former implies a requirement for the latter:

> "the tax (fiscal) system should preserve the utility order, implying that if two individuals would have the same utility level in the absence of taxation (transfers), they should also have the same utility level if there is a tax (transfer)."

(Feldstein, 1976, p. 94).

If two unequals are reranked by some redistribution then it could be argued at a conceptual level that at a particular point in that process of redistribution, these two unequals became equals and were then made unequal (and reranked), thus violating classical horizontal equity.

[22] The concentration coefficient is 1 minus twice the area under a concentration curve. A concentration curve for a given variable *y* (e.g. post-support income) is "the share of total *y* received by observations with an income of *x* or less, graphed against the population share of those with an income no greater than *x*" (Jenkins, 1988, p. 66).

4.3.3 Relevant literature

The origin of measuring redistributive effect dates back to Kakwani (1977), who first defined it as $R = \left(\frac{g}{1-g}\right)K_T$ where g is the average transfer rate and K_T is Kakwani's index of progressivity, specified as the difference between the concentration coefficient of transfers ranked by pre-transfer income and the Gini coefficient of pre-transfer income, $C_T - G_X$. The index of progressivity measures the degree of disproportionality in the distribution of transfers, i.e. how much more or less unequal is the distribution of transfers in comparison with the distribution of pre-transfer incomes. If the index is positive (negative), then support is progressive (regressive), meaning that the poorer the farmers the more (less) support they receive in relative terms (Kakwani, *Ibid.*).

Later on Kakwani modified his measure of redistributive effect, having recognized that his earlier formula holds only if the transfers do not induce any reranking; otherwise it does not measure a net redistributive effect (Kakwani, 1984). He emphasized the importance of the distinction between the measure of progressivity and that of redistributive effect. His new measure includes the impact that reranking has on the redistributive effect, i.e. it takes into consideration the fact that if reranking occurs, it offsets some of the redistributive effect. Therefore the new R is

$$R = G_X - G_Y = (G_X - C_Y) + (C_Y - G_Y) = \frac{g}{1-g}K_T + (C_Y - G_Y) = V + H \tag{4.8}$$

The vertical component, $V = \frac{g}{1-g}K_T$ (equivalent to his old measure) represents the gross redistributive impact of the fiscal system brought about by the different treatment of different income units, corresponding to the vertical equity component. The new, horizontal component H is zero if the ranking of income units is unaltered in the transition process. Violating horizontal equity and therefore causing reranking will result in a negative value of H, in which case it will offset some of the redistributive effect.

In their seminal paper, Aronson *et al*. (1994) modified Kakwani's presentation further in a way that allows identifying reranking and horizontal inequality as separate contributions to the redistributive effect. They do it by specifying a transfer function applicable to all individuals; the HI arises because this function is assumed to be stochastic, which means that income units with comparable income receive different transfers. Formally, this can be represented as $T_i = T(x_i) + \varepsilon_i$, where $i=1,\dots n$ where x_i is the pre-support income for individual i, T_i is the support received by individual i and ε_i is a *disturbance term* with zero mean for each pre-transfer income level. This model can capture the randomness in the transfers for units with the same level of pre-support income. When such randomness occurs, $T(x_i)$ is the expected transfer value for individual i and ε_i is an assessment error. This methodology is applicable to homogenous population (for example cattle farms, or outside of agricultural context, single people); hence when heterogeneous groups are analysed one needs to introduce types, which will be developed in the following section.

4.3.4 Redistributive effect decomposition

Allanson (2006, 2007, 2008; Allanson and Rocchi, 2008), building upon the work of Aronson *et al*. (1994), developed a methodology which decomposes the horizontal part of the redistributive effect into a component induced by reranking and that caused by classical horizontal inequalities, where the latter is further separated into the impact of discrimination between and within farm types (in the spirit of Kakwani and Lambert (1999)). The subsequent presentation follows Allanson's (2008) notations.

The full decomposition of the redistributive effect can be written as

$$R = A_X - A_Y = H_W + H_B + H_R + V \tag{4.9}$$

where H_W and H_B represent the redistributive effect of respectively within and between type classical HI, $H_W + H_B = H_C$. H_R measures the reranking effect, and V signifies the vertical equity component.

The crucial issue for estimating the classical HI components is the specification of *reference functions*, with each function providing mapping from pre-transfer to post-transfer incomes in the absence of particular source of HI (Jenkins and Lambert, 1999).

The starting point of the decomposition is the observation that agricultural policy in most countries is based on a number of commodity regimes, and the incidence of transfers within a specific regime will be usually determined by a combination of current and historical levels or factors of production. This means that in order to explore the organisation of agricultural policy, one needs to specify separate functions for different regimes. Accordingly, separate functions are specified for distinct sub-populations of farms which produce similar combinations of agricultural products;

farms are divided into 7 categories, according to the main commodity produced[23]. For vectors of observations on pre-support incomes $x=(x_1...,x_k,...x_K)$, subsidies $t=(t_1...,t_k...,t_K)$, and post-subsidy incomes $y=(y_1,...y_k,...y_K)$ (with y_k, t_k and x_k being sub-vectors of observations on type k farms), by definition $y = x + t$. In the spirit of Aronson *et al*. (1994) the relationship between the pre-support and post-support income for type k can be described as:

$$y_{ik} = g_k(x_{ik}) + \varepsilon_{ik} = E[y_{ik} \mid x_{ik}] + \varepsilon_{ik} = x_{ik} + E[t_{ik} \mid x_{ik}] + \varepsilon_{ik} = x_{ik} + t_x(x_{ik}) + \varepsilon_{ik}; \qquad (4.10)$$

$k = 1,\ldots.K;\; i=1,\ldots.n_k.$

where x_{ik}, y_{ik}, t_{ik}, and ε_{ik} are pre-support income, post-support income, transfer level and disturbance term for farm i in type k. $g_k(x_{ik}) = x_{ik} + t_k(x_{ik})$ is the expected value of post-subsidy income conditional on the farm type and pre-subsidy income, $t_k(x_{ik})$ is the expected transfer level given farm type and pre-subsidy income, and ε_{ik} is the disturbance term with zero mean for each pre-transfer income level. The disturbance term represents the possibility that farms of type k which have identical pre-support incomes may obtain different levels of transfers due to differences in factors like managerial ability, historical developments or natural resource endowments. For example, in commodity regimes where the support level is linked to current levels of inputs and outputs, any given level of pre-transfer income may be associated with a range of input and output combinations, leading to a dispersion of transfer levels. With decoupled payment schemes, the link between the incidence of support and pre-transfer incomes through current production choices is expressly broken, but the link with historical support levels maintains the possibility of a dispersion of transfers.

[23] The FAS dataset separates farms into 8 different types. However, in this analysis Lowland Sheep and Cattle category was integrated into LFA Sheep, LFA Cattle or LFA Sheep and Cattle since there were not enough observations to perform meaningful analysis for this type.

The shape of the reference functions will depend on how expected transfers vary with pre-transfer income; in general, the magnitude of both is expected to be more or less proportionate to the scale of production. Still, given how complex the commodity regimes and agricultural production processes are, it will not be possible to specify the precise form of this relationship. For that reason, the set of $g_k(\boldsymbol{x}_{ik})$ functions are simply assumed to be continuous, smooth functions, which generate a non-parametric model with only very weak constraints on its structure.

Given the specification function in equation (4.10), two possible sources of classical HI can be identified. Firstly, the within-type HI will be demonstrated by the dispersion about the conditional mean $E[y_{ik}|\ x_{ik}]$. Therefore the disturbance term ε_k captures the possibility that farms of the same type with identical pre-support income may obtain different levels of transfers. Only when the disturbance term is zero there will be no within-type HI and this is represented by a vector of post-support incomes $h_W(x) = [g_1(x_1),...g_k(x_k),...g_K(x_K)]$. If A_W is defined as the absolute Gini index of $h_W(x)$, we can define $H_W = A_W - A_Y$, which shows that the within-type HI can be measured as the difference in inequality between $h_W(x)$ incomes and post-subsidy incomes *y*, and it will be non-positive asymptotically[24].

The other source of classical HI is systematic discrimination between farm types. Since the reference functions are type-specific, farms that have identical pre-support income may be expected to receive different transfers depending on their type, and the size of

[24] This is because the Lorenz curve for the reference functions will be situated on or above the Lorenz curve for *y* due to the fact that $h_W(x)$ could be obtained by performing a "series of progressive mean-preserving transfers" (Allanson, 2008, p. 25; Dasgupta *et al.*, 1973). Therefore the inequality of $h_W(x)$ will be less than that for *y*, and H_W will be non-positive asymptotically, but might happen to be positive in a finite sample.

this divergence reveals the magnitude of between-type HI. There will be no between-type HI if $g_k(x_{ik}) = g(x_{ik})$ for all k, and thus $h_w(x) = g(x)$ which means a one-to-one mapping from pre-transfer incomes to post-transfer incomes for all farms, and *t(x)* will be the non-discriminatory transfer level. For lack of theory to guide the specification of this non-discriminatory reference function, it is assumed that between-type HI will change the distribution of the transfers, but their overall value for any given pre-support income will stay the same (Allanson, 2008). Consequently, the expected value of post-support income given the pre-support income, but without taking the type of farm into consideration, can be obtained as weighted sum of the post-support income functions for the different types:

$$h_B(x) = \sum_{k=1}^{K} w_k(x) g_k(x); \quad \text{where } \sum_{k=1}^{K} w_k(x) = 1 \tag{4.11}$$

The weights, which sum up to a unit vector, are determined locally, in relation to relative frequencies of the types of farms at any given pre-support income[25]. The between-type HI can then be measured as the difference in inequality between $h_B(x)$ and $h_W(x)$, that is $H_B = A_B - A_W$, where A_B is defined as the absolute Gini index for $h_B(x)$. Since $h_B(x)$ is a weighted average of the $g_k(x)$ functions, its Lorenz curve will be situated on or above the Lorenz curve of $h_W(x)$, and thus the difference between the two Gini indices will be non-positive (Allanson, 2008).

Only when $y = h_B(x)$ there will be a one-to-one mapping from pre-transfers incomes to post-transfer incomes which implies no classical HI. The total size of classical HI, that is the sum of the within-type and between-type HI, will be reflected by the extent of

[25] Instead of being determined globally according to proportions of each type of farms in the population.

divergence of post-support income from the non-discriminatory function $h_B(x)$. Putting the two components together gives:

$$H_w + H_B = A_W - A_Y + A_B - A_W = A_B - A_Y \tag{4.12}$$

As mentioned earlier, the total redistributive effect is given by $A_X - A_Y$. This means the identification of the classical HI components leaves $A_X - A_B$, which is the measure of the difference in inequality between the pre-support incomes and the non-discriminatory post-support incomes. This residual can be further decomposed into vertical and horizontal components. Following Kakwani (1984), the decomposition can be written as:

$$A_X - A_B = \overline{y}_B[C_B - G_B] + [\overline{x}G_X - \overline{y}_B C_B] = H_R + V \tag{4.13}$$

where C_B is the concentration index of non-discriminatory post-support incomes ranked by the order of pre-support incomes, G_X is the ordinary Gini coefficient of pre-support income, $\overline{x}$ is mean pre-support income, G_B is the Gini coefficient of non-discriminatory post-support income and $\overline{y}_B$ is the mean non-discriminatory post-support income.

The horizontal component H_R, which measures the reranking effect in the income distribution, is the product of the average post-support income $\overline{y}_B$ and $C_B - G_B$, which can be identified with the reranking index of Atkinson (1980) and Plotnick (1981). This component is non-positive, which reflects the fact that reranking causes unfairness in the distribution of support and therefore affects the redistributive effect negatively. Reranking will not occur if $h_B(x)$ is an increasing function of x over the whole range of pre-support incomes.

The vertical component measures the progressivity of support and can be perceived as an *index of gross redistributive effect* (Allanson, 2008). It can be rewritten as:

$$V = [\bar{x}G_X - \bar{y}_B C_B] = -C_{T_B}\bar{t}_B \qquad (4.14)$$

where $\bar{t}_B$ is the mean value of non-discriminatory transfers and C_{T_B} is the concentration coefficient of non-discriminatory transfers ranked according to pre-transfer incomes. One can define a disparity index D = - C_{T_B}, which will be positive if support is progressive in absolute terms, negative if it is regressive and zero if benefits do not depend on the pre-support income. The gross redistributive index is proportional to the mean value of non-discriminatory transfers for any given *D*. The gross redistributive effect is in general more positive/ less negative than *R* due to the presence of different types of HI that reduce the redistributive effectiveness of support.

4.3.5 Estimation procedures

The key aspect of obtaining the estimates of different components of *R* is the estimation of the reference functions. Following Allanson and Rocchi (2008), the set of reference functions in equation (4.10) can be estimated using a sample of n_k observations on pre-transfer and post-transfer incomes for all types of farms; it can be done parametrically or non-parametrically. The first method assumes some pre-specified functional form; parametric statistical procedures are based on assumptions about the shape of the distribution in the population (normal distribution) and about the form of the parameters, like means or standard deviations. Because of the complexity that the agricultural production activity and the commodity regimes demonstrate, the precise functional form of the function is not specifiable. Accordingly, a non-parametric estimation is employed. Non-parametric statistical procedures can be defined "as a class of statistical procedures that do not rely on assumptions about the shape or form of the probability distribution from which the data were drawn" (Hoskin, n.d., p.1). The functions are assumed to be smooth and continuous, without the need to impose any strong constraints on their structure. For the purpose of this study, the variable span smoother of Sasieni (1998) is employed to smooth y_k on x_k.

> "The smooth is a running line fit with a variable span (…) which is chosen at each point by cross validation on the mean squared error of prediction. The span at each point is smoothed to produce the variable span used to smooth the data"
>
> (Sasieni, 1998, p. 4).

The number of observations employed at each data point is chosen by the variable span of the smoother. The suitability of non-parametric estimation will be tested empirically by comparing the predictive power of parametric and non-parametric estimates.

The non-discriminatory function in equation (4.11) can be estimated non-parametrically using kernel density estimates of the weight functions $w_k(x_k)$ (Kakwani and Lambert, 1999), but it will not be possible to achieve reliable estimates unless the number of observations on each type of farm is large enough. Alternatively, it can also be estimated using Sasieni's technique of variable span smoother, but using the pooled sample of $n = \sum n_k$ observations.

Absolute Gini and concentration indices are obtained using the weighted sample formulae of Lerman and Yitzhaki (1989), who developed a method to measure the Gini coefficient which does not require grouping of income units and thus disregarding differences within groups. They prove that the Gini coefficient is twice the covariance between a variable and its rank divided by the product of the variable's mean and the sample size

$$G = \frac{2\operatorname{cov}[y, F(y)]}{\bar{y}} \tag{4.15}$$

In a weighted sample, the estimator of the cumulative distribution *F(y)* is its mid-interval:

$$\hat{F}_i(y) = \sum_{j=0}^{i-1} w_j + \frac{w_i}{n} \tag{4.16}$$

This formula can be used to calculate weighted covariance between the variable and its cumulative distribution. Hence, for weighted data the formula used is:

$$G = 2\sum_{i=1}^{n} w_i (y_i - \bar{y})(F_i - \hat{\bar{F}}) / \bar{y} \tag{4.17}$$

where $\bar{y}$ is the weighted mean of income.

The standard errors are obtained using bootstrapping (Efron, 1979). Bootstrapping is a technique used in statistical interference to measure the properties of an estimator based on a sampling distribution obtained through resampling with replacement from the sample at hand. A large number of bootstrapping samples of size *n* from the original sample are drawn in order to approximate the distribution of the population (1000 replications in this case). The relationship of the bootstrapping sample to the original sample is like that of the sample to the population. Such an approach allows for the estimation of the sampling distribution of a statistic without the need to make assumptions about the distribution of the population.

4.4 Empirical section

The empirical section starts with the discussion on the data and variables creation; this is followed by an explanation of the hypothetical policy scenarios which are modelled. Lastly the results are presented; firstly from the actual distribution under historic model, and then two alternative scenarios. This is concluded with comparison to Allanson's (2008) results from before the SFP introduction.

4.4.1 Data and variables construction

The study uses micro-level weighted data from Farm Accounts Survey (FAS) for years 2006 - 2010, which correspond to production years 2005/06 – 2009/10.

The measure of post-transfer income used in the study is the Cash Income measure as recorded by FAS. It is obtained by calculating the difference between total trading revenue (crop and livestock revenues, subsidies and payments) and total trading expenditure (variable costs, general overheads[26], fuel, repairs, rent paid, paid labour). Revenue represents receipts adjusted for debtors and expenditure is purchases adjusted for creditors. It represents the cash return to individuals for their managerial and manual labour input and on their investment in the enterprise. Factors not included in the calculation of cash income are: depreciation on fixed assets, change in the value of livestock and crop, imputed labour costs and imputed unpaid labour of non-principal partners, directors and their spouses, as well as imputed rents. This means that farms which own their land and labour are better off in the analysis than farms which have to

[26] Overheads are expenses which cannot readily be traced to processes that result in particular single products.

undergo additional expenditure to hire land and labour. This measure is chosen as it seems to be the best representative of what is available to farmers for their spending purposes and therefore it corresponds closely to the income position as perceived by a farmer (Allanson, 2008).

Pre-transfer income is Cash Income minus the net value of the transfers. The gross value of support is the total amount of money that farmers receive. Three sources of support are distinguished: support through market prices, the SFP, and all other grants and subsidies (payments under Pillars I and II, and national grant schemes). Market price support is calculated using OECD (2011) data on the gap between domestic and international prices for the main commodities, which is measured at farm gate level.

It is recognized that the benefits of support do not always fully accrue to farmers but are dispersed among the owners of factors of production (OECD, 2003). This requires an approach to calculate the net value of transfers that accrue to farmers, which depends on how much it increases the returns to factors of production owned by farmers, where other beneficiaries might include the landlords or hired workers.

Following the and Allanson and Rocchi (2008) follow the OECD (2003) approach to calculating transfer efficiency of payments, which is based on the assumption that "farmers can capture only that part of the support that remunerates the factors of production they themselves own" (OECD, Ibid., p. 8). It is therefore important to know the shares of factors of production owned by the farmer. More specifically, the static impact on farm incomes from a unit increase in output revenues (due to market price support, output payments or a decrease in set-aside requirements) is equal to the combined share of the farm-owned factors of production, whereas that from a unit increase in direct payments, or grants and subsidies to individual inputs is equal to the farm-owned share of those inputs. In the case of the SFP which is a direct payment to land, this would imply that farmers who rent land do not receive any of the value of the SFP tied to this rented land, as this will simply be reflected in higher rents.

In terms of technical details behind the methodology, estimates of combined income share from land, labour and capital by farm type are obtained by calculating the ratio of average gross value added to average output revenue from the farm-level data. Next, income shares from land and labour are estimated separately from sub-samples of farms with hired labour and rented land only, leaving a residual share accrued to capital. The methodology, following Allanson and Rocchi (2008), assumes that farmer maximizes profit of the form:

$$\Pi = pY - (rA + wL + mK + vX) + sA \tag{4.18}$$

Output Y is produced using four factors of production: land (A), labour (L), management and capital supplied by the farm (K) and variable inputs (X). s is the value of subsidy per hectare. We assume constant returns to scale Cobb-Douglas production function. The elasticities of factors of production are: α for land, β for labour, γ for management and capital, and (1-α-β-γ) for variable inputs. The first order conditions for maximization of profit are respectively:

- $(r-s)A = \alpha pY,$
- $wL = \beta pY,$
- $mK = \gamma pY$
- $vX = (1-\alpha-\beta-\gamma)pY.$

The information on revenue pY, subsidies sA and the value added net of subsidies $rA + wL + mK = (pY - vX)$ is available in FAS data irrespective of the ownership of land or labour arrangement. The net value added share of market revenues $\varphi = (\alpha + \beta + \gamma)$ can be obtained by estimating a weighted average value of the ratio $\hat{\varphi} = (pY - vX)/pY$. Information on wages and rents for unpaid labour and owned land is contained in FAS data, thus r and w can be calculated based on it.

Given that, the weighted sample average value of the ratios $\hat{\alpha} = (r-s)A/pY$ and $\hat{\beta} = wL/pY$ can be derived. We can label σ_A , σ_L, σ_K and σ_X the proportions of factors of production that belong to the farm family, assuming that $\sigma_K = 1$ and $\sigma_X = 0$. If we define the total farm income as

$$I = \sigma_A rA + \sigma_L wL + mK + \sigma_A sA \tag{4.19}$$

we can then estimate

$$\hat{I} = (\overline{\hat{\varphi}} - ((1 - \sigma_A)\overline{\hat{\alpha}} + (1 - \sigma_L)\overline{\hat{\beta}})pY + \sigma_A sA. \tag{4.20}$$

Accordingly, $(\overline{\hat{\varphi}} - ((1 - \sigma_A)\overline{\hat{\alpha}} + (1 - \sigma_L)\overline{\hat{\beta}})$ proportion of £1 increase in revenue and σ_L proportion of £1 increase in land subsidy will contribute towards higher income for the farmers. Such identification allows obtaining the net value of the transfer that benefits the farmers.

Since farm-owned shares of factors of production are derived for individual farms, the effective passthrough of support can vary between farms depending on the mix of support measures and the ownership structure of the farm.

This study takes a step further in the approach towards calculation of the decoupled direct payments, with the improvement of explicitly estimating the passthrough rate of the SFP. The OECD's approach is very simplified in that it assumes that farmers which rent land do not obtain any of the SFP value; such high capitalisation rate is unlikely in a short period, and since SFP is a dominant share of support from 2005 onwards, it was important to improve the assumption used in calculating its transfer efficiency; an empirically estimated passthrough rate improves the accuracy of this assumption. Therefore in order to calculate the net value of SFP for farmers who rent the land, the estimate of average passthrough from Chapter 3 (85 per cent) is used. This means that out of every pound from the SFP transfer, 85 pence goes to the farmer and 15 pence goes to the landlord in the form of higher rents. This is used for any SFP payments tied to rented land, whether the farmer rents all the land or just part of it; in the latter case the share of overall SFP value which corresponds to the share of rented land is multiplied by the passthrough rate.

4.4.2 Policy scenarios

The first part of the analysis was performed using data with distribution of support based on the historic model (referred to from now on as *historic model*). Additionally, a set of results was generated by simulating what the distribution of support would have been with the regional model in place, with two alternative scenarios:

- flat rate across the whole Scotland (*flat rate* scenario from now on),
- one rate for Less-Favoured Areas (LFA) and another for non-LFA (*LFA/non-LFA* scenario from now on).

The first scenario is in accordance with other small countries that implemented the regional model treating the whole territory as one region, for example Slovenia. The second scenario limits the extent of redistribution of support by dividing the territory into different regions based on land productivity; this sort of model was implemented in England. The division of land according to LFA and non-LFA regions is in line with the proposal of Pack (2010b) in his final inquiry report into the future or agricultural support in Scotland[27]. The inquiry suggests this method as a " way of distinguishing between types of farming with different needs, opportunities and choices" (*Ibid.*, p. 72). The specific classification is proposed because it is widely used across Europe and because the distinction has already been mapped and boundaries have been established.

Around 85% of land in Scotland is classified as LFA, and these areas mainly consist of permanent grass and rough grazing, which limits the choice of activities for farmers. As a consequence, these areas are usually used for ruminants, with suckled beef playing a particularly important role. While agricultural production on this land plays an important role in terms of provision of public goods, it is also a highly uncompetitive way to produce meat, and it is at risk of disappearing without support. The remaining 15% of Scottish agricultural land is of good quality and not classified as LFA; it can be used for a wide range of production and it has high returns to inputs (Pack, 2010b).

[27] The Interim report (Pack, 2010a) proposed an alternative solution, with regions divided according to land capability using Macaulay Land Capability for Agriculture (LCA) classification, with three rates of support available. The final report walked away from this solution since modelling showed that it "led to significant reductions in support across many of the farm types important to Scotland" (Pack, 2010b, p. 106) and also due to technical difficulties with the implementation.

4.4.3 Results

4.4.3.1 Historic model

Table 4.1 presents weighted summary statistics by year for all farm types under the actual distribution of support with historic model in place. The low value of average pre-transfer income (with negative figures in 2006 and 2007), together with the high percentage of farms that suffer from negative pre-transfer income, highlight the chronic dependence of Scottish agriculture on support. Average post-transfer income is positive in every year, however, between 5% and 8% of farms suffer from negative income even after the support was provided.

The average pre-transfer income has increased from negative figures in 2006 and 2007 to positive ones in the last three years of the study. This reflects positive market trends in those years: rising global demand for crops, favourable currency exchange which increased the value of the SFP, good prices for finished cattle and calves, and high prices for sheep (SGRERAD, 2009 - 2012). The increase in the average pre-transfer and post-transfer incomes throughout the sample period might suggest a positive trend in Scottish agricultural incomes with a corresponding slight reduction in the degree of dependency on the support, but a longer time horizon would need to be studied to draw more definite conclusions.

Table 4.1 Weighted summary statistics by year, actual distribution.

	2006	2007	2008	2009	2010
Number of observations	474	458	443	479	484
Farm business size (ESU)	54	55	55	58	59
Post-transfer income (£)	31263	34245	44568	47465	48935
% of farms with post-transfer income<0	6%	7%	8%	8%	5%
Pre-transfer income (£)	-8320	-5065	4865	5850	1753
% of farms with pre-transfer income<0	68%	63%	51%	52%	54%
Gross support (£)	57913	57179	53337	54152	61299
Components:					
Market price support	18235	19210	13434	11689	13697
Single Payment Scheme	28496	29646	29235	33598	38563
Other grants and subsidies	11182	8323	10668	8864	9039
Net transfer to farmers (£)	39583	39311	39703	41615	47182
Components:					
Market price support	6354	6467	4890	4225	4948
Single Payment Scheme	26953	28045	27735	31912	36614
Other grants and subsidies	6276	4799	7078	5478	5620
Net support as % of post-support income	127%	115%	89%	88%	96%

The mean value of support ranges between 53337 in 2008 and 61299 in 2010. However, leakages to other factors of production meant that farmers did not receive the full value of this support, with the percentage of passthrough ranging between 68% in 2006 and 77% in 2010. The Single Payment is the main source of support, on average accounting for between 49% to 63% of gross transfers; its contribution to net support is higher, in the range of 68% and 78%. The passthrough of SFP is higher than for market price support and other grants and subsidies, hence bigger role played in net support. Over the study period, the share of Single Payment in the net transfer increased, reducing the contribution of market price support and other grants and subsidies in net transfers from 16% each in 2006 to 10% and 12%, respectively, in 2010.

Table 4.2 Weighted summary statistics by farm type, actual distribution.

	All	*Cereal*	*General Cropping*	*Dairy*	*Specialist Sheep*	*Specialist Cattle*	*Cattle & Sheep*	*Mixed*
Number of observations	468	66	46	58	41	121	70	65
Farm business size (ESU)	56	62	104	103	15	39	42	58
Post-transfer income (£)	41295	45847	59452	64573	22470	31842	36153	44420
% of farms with post-transfer income<0	7%	10%	4%	4%	3%	9%	7%	7%
Pre-transfer income (£)	-184	10926	22690	21396	-6245	-14018	-11453	-4267
% of farms with pre-transfer income<0	58%	36%	35%	31%	68%	76%	72%	59%
Gross support (£)	56776	38400	46137	62838	33994	67001	70849	67542
Components:								
Market price support	15253	1694	9032	28873	5904	19983	18706	20005
Single Payment Scheme	31908	34543	34221	30380	17620	32327	34383	39413
Other grants and subsidies	9615	2163	2883	3585	10469	14691	17760	8123
Net transfer to farmers (£)	41479	34921	36761	43176	28716	45860	47606	48686
Components:								
Market price support	5377	473	2691	11256	3940	6578	6129	6289
Single Payment Scheme	30252	33048	32295	29674	16875	30530	31952	37285
Other grants and subsidies	5850	1399	1776	2246	7901	8752	9525	5113
Net support as % of post-support income	103%	83%	67%	70%	133%	146%	135%	111%

Table 4.2 presents the results by farm type, averaged across the years. It can be seen that pre-transfer incomes are consistently negative for livestock farms, which are usually enterprises of smaller economic size with worse quality land, and for mixed farms. General Cropping and Dairy farms have the highest average pre-transfer and post-transfer incomes. The lowest average post-transfer incomes are received by livestock farms, particularly Sheep; Sheep farms are also the ones that receive the lowest average value of support. Specialist Cattle and Cattle & Sheep farms, on the other hand, received the highest mean support, closely followed by Dairy farms. The standard deviation of net transfers across farm types is significantly lower than for gross support (it goes down from 15324 to 7491), which indicates that transfer efficiency which will vary for different combinations of support types act to reduce dispersion in average transfer levels between farm types.

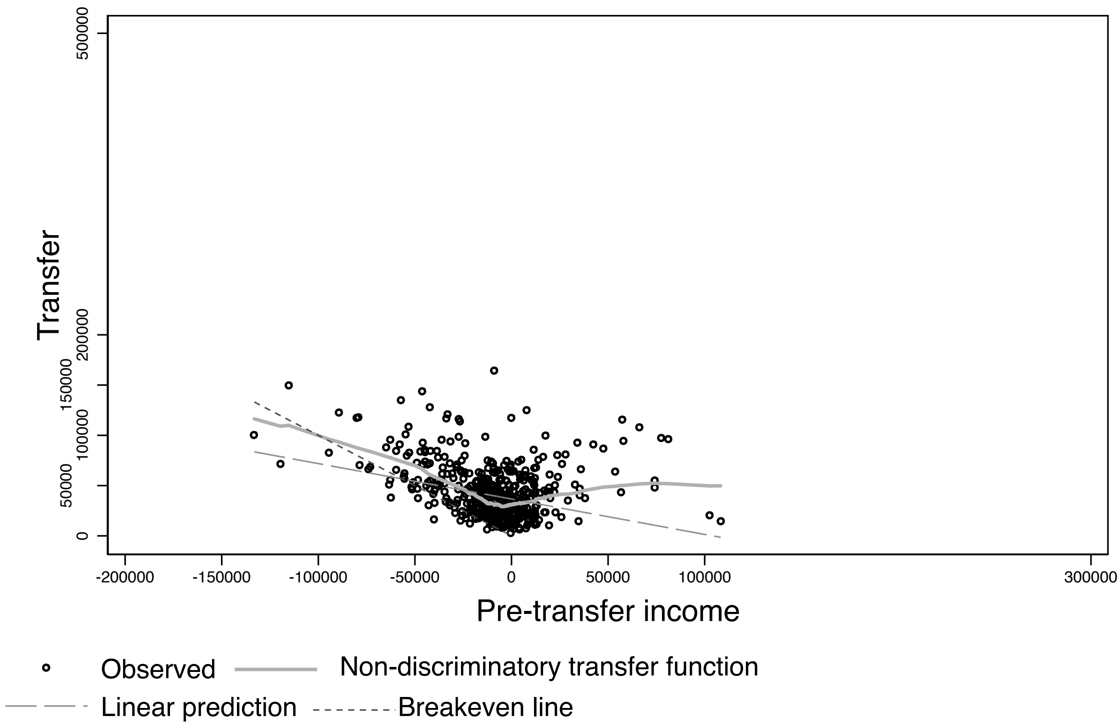
Comparison of the standard deviations for pre-transfer versus post-transfer incomes by farm type reveals a reduction in the degree of dispersion (from 15412 to 14928). By implication the provision of support on average acted to reduce income disparities between farm types in Scotland, contrary to the findings of the OECD (2003) report that agricultural support increases income disparities between farm types in most countries.

The SFP constitutes the main source of support for all farm types, however, there are some differences between farm types in terms of the contribution of different support types. Market price support on average constitutes 13% of net support, but for Dairy farms this figure is 26% as historically the majority of support to dairy farmers was delivered through market price support (OECD, 2005) and prices for dairy products in the EU are still considerably higher than the world prices (European Commission, 2011b). While the average share of other grants and subsidies in net support is 14%, for Specialist Sheep and Specialist Cattle farms this figure is higher, at 28% and 19% respectively. This is because the livestock farms are on poor quality land and they benefit from various agri-environmental and LFA payments. The SFP on average accounted for 73% of net support, but for farm types that now benefit relatively little from market price support and other grants and subsidies this figure was higher; on average Cereal farms got 95% of net support from the payment and General Cropping farms got 88%.

Figures 4.1 - 4.5 plot the estimation results for each year: scatterplot of observations on pre-support incomes and transfer levels together with the results from the nonparametric estimation of the non-discriminatory transfers plotted against pre-support incomes in Panel A, and the set of farm type specific transfer functions $t_k(x_{ik})$ (from equation (4.10)) plotted together with the non-discriminatory transfer function against pre-support incomes in Panel B.

Figure 4.1 Non-discriminatory transfer function and farm type specific functions, historic model, 2006.

Panel A



Panel B

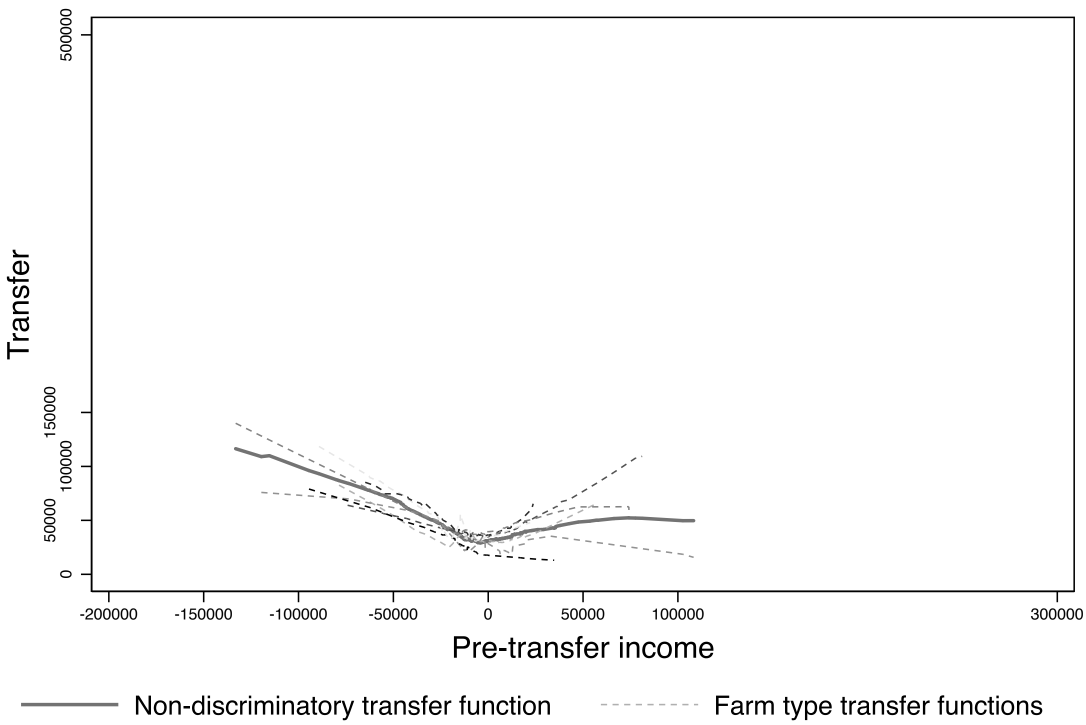
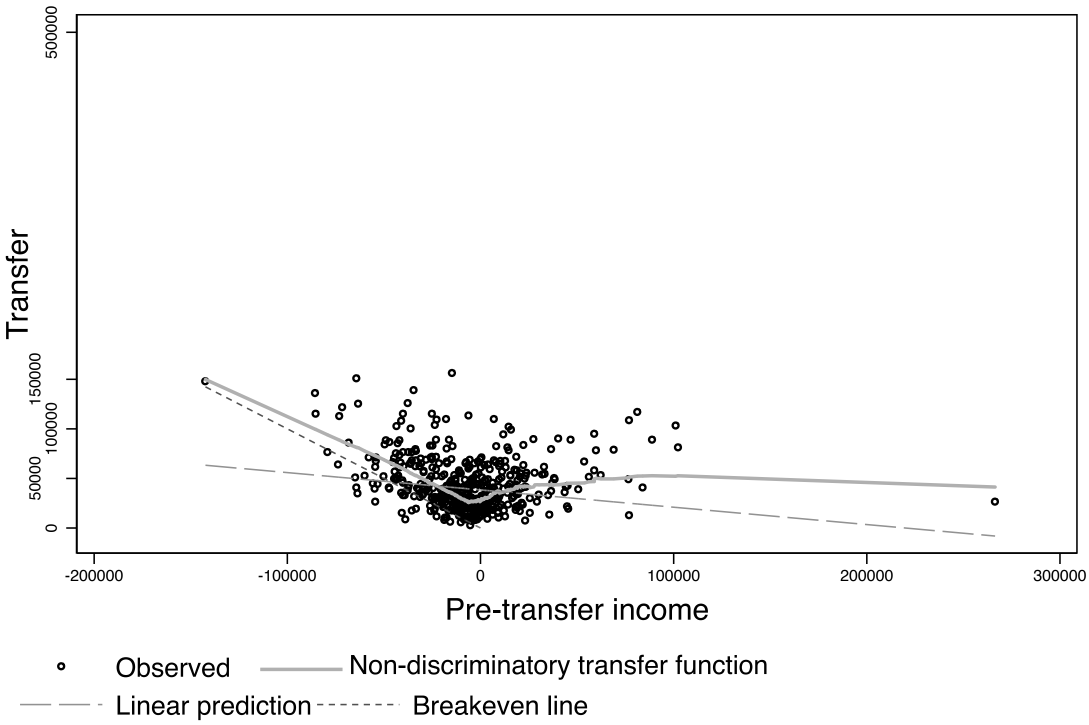


Figure 4.2 Non-discriminatory transfer function and farm type specific functions, historic model, 2007.

Panel A



Panel B

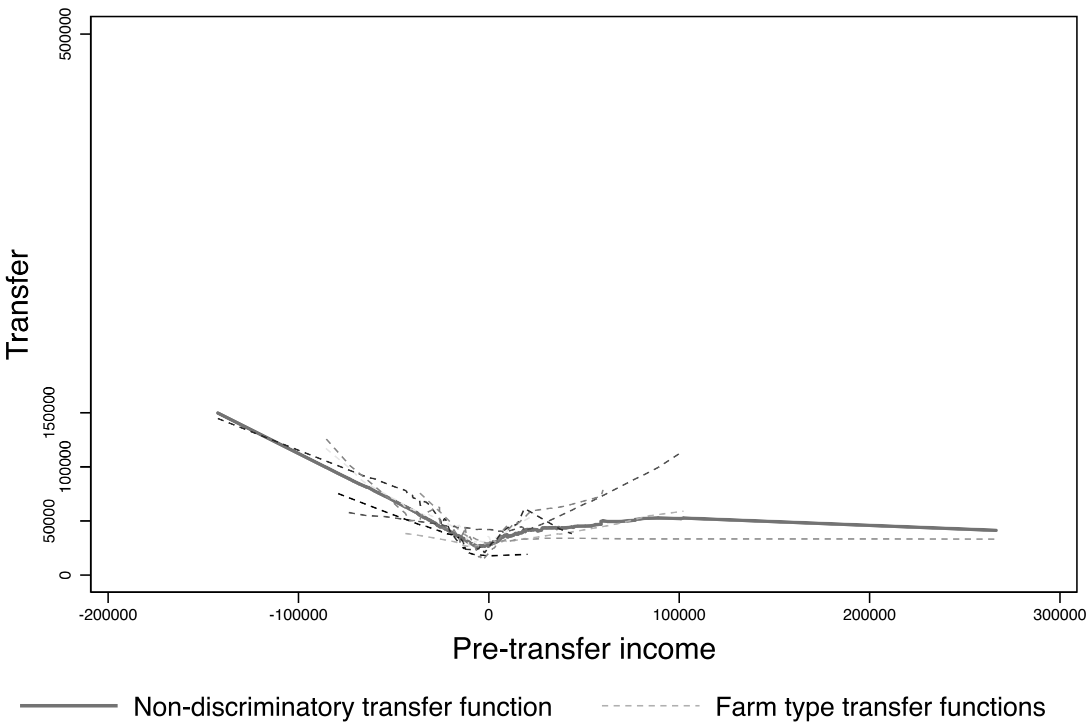
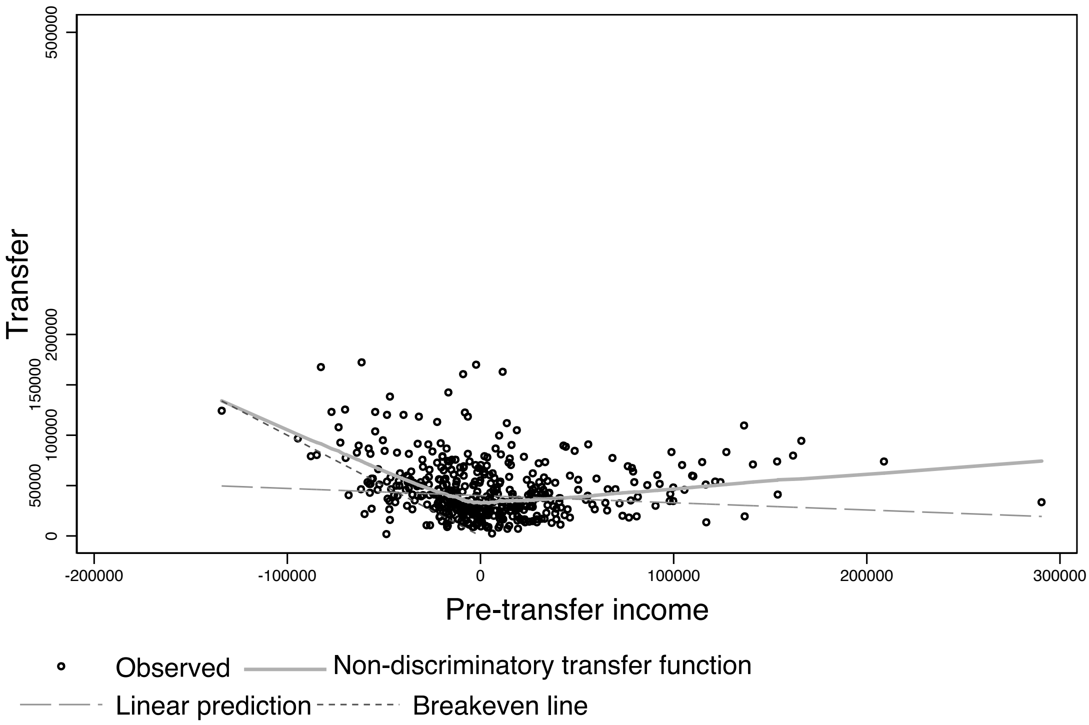


Figure 4.3 Non-discriminatory transfer function and farm type specific functions, historic model, 2008.

Panel A



Panel B

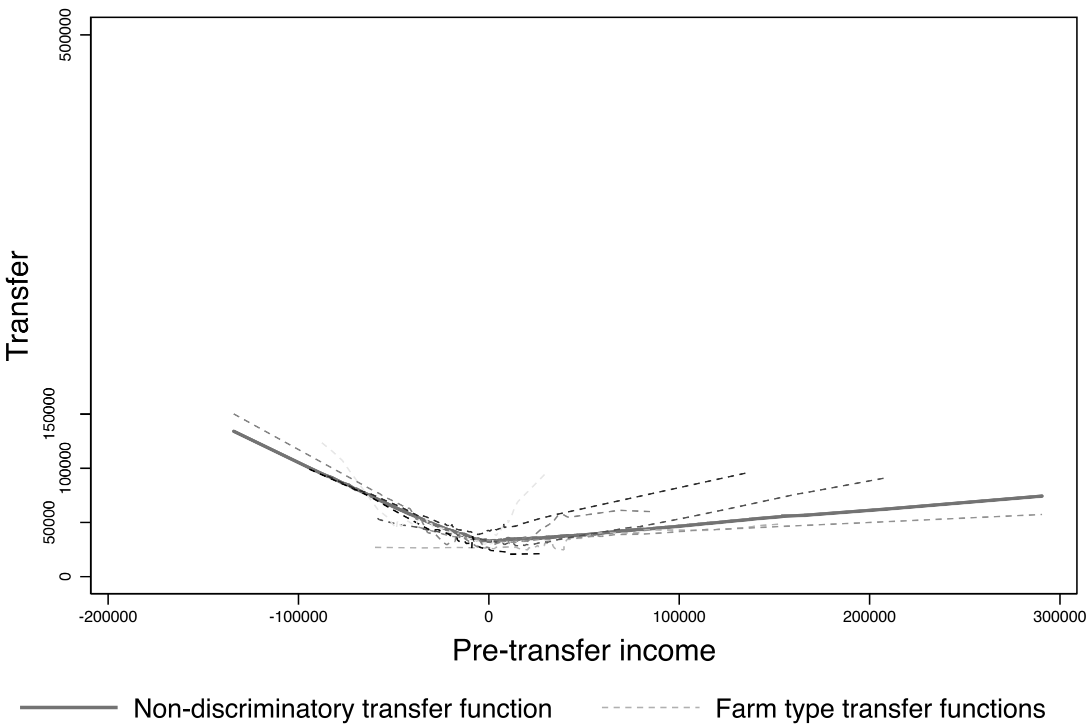
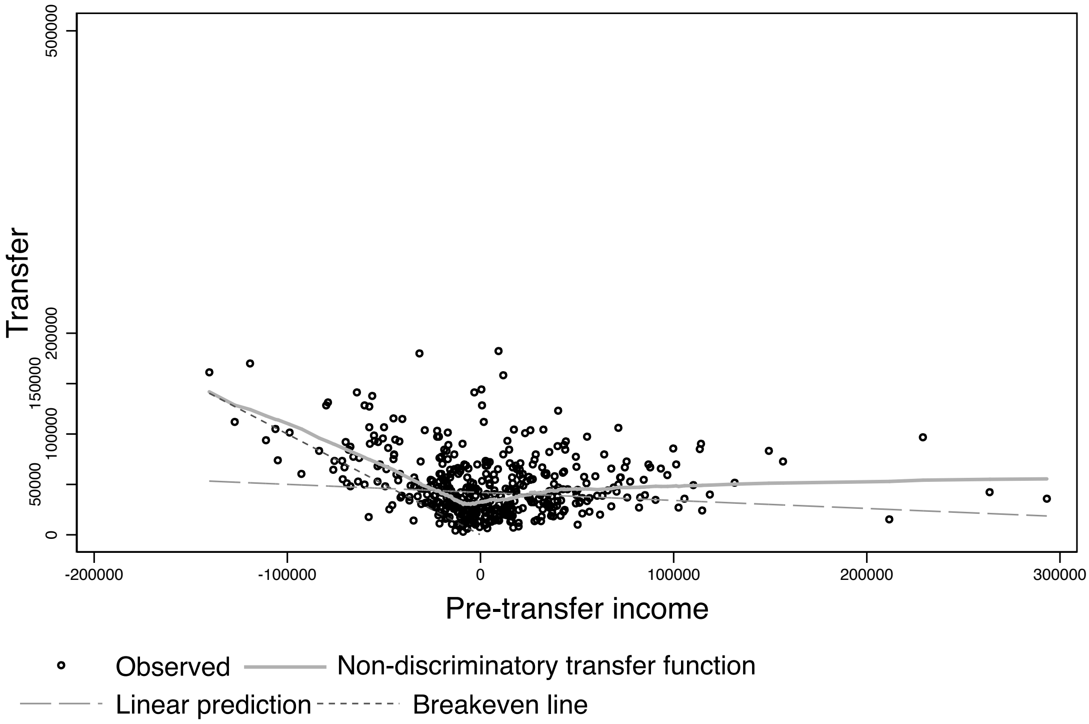


Figure 4.4 Non-discriminatory transfer function and farm type specific functions, historic model, 2009.

Panel A



Panel B

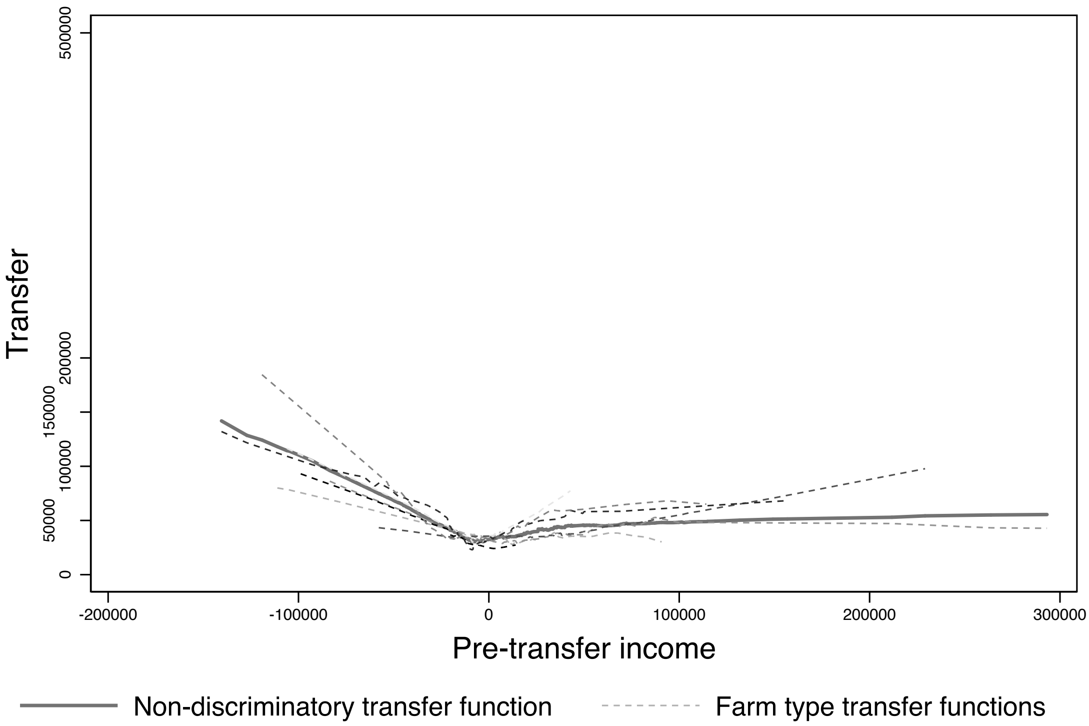
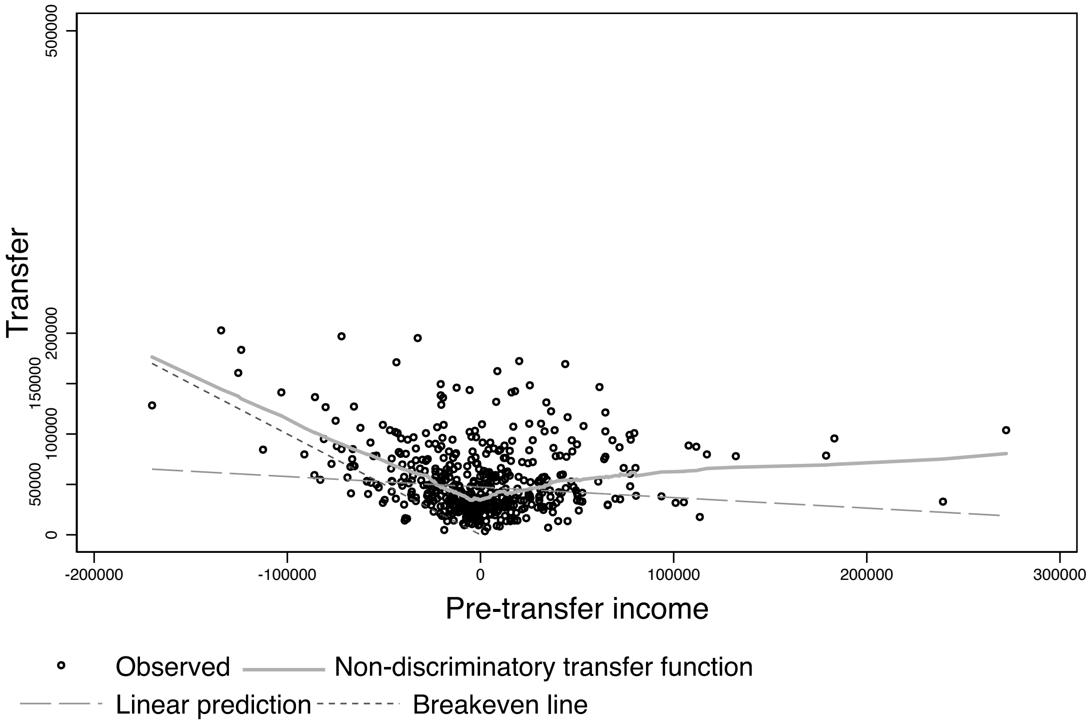
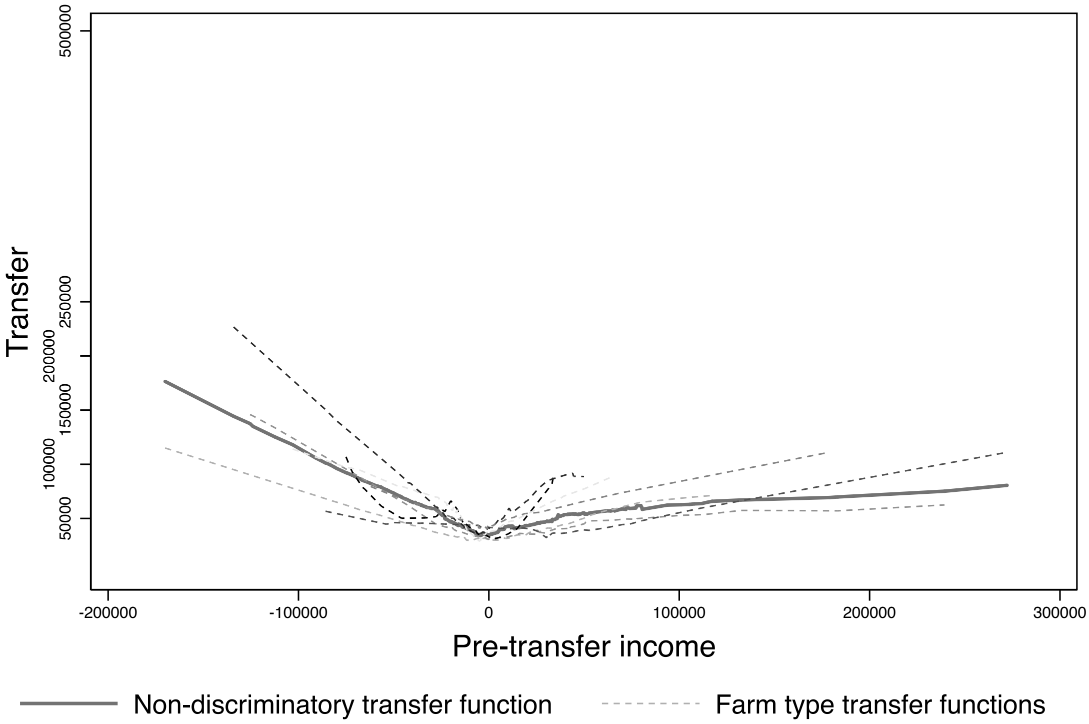


Figure 4.5 Non-discriminatory transfer function and farm type specific functions, historic model, 2010.

Panel A



Panel B



Panel A in each figure provides scatterplots of observations on pre-transfer incomes and transfers, linear regression of the transfers on pre-transfer incomes and the non-discriminatory transfer functions. The purpose of this graph is to show the shape of the relationship between pre-support incomes and transfer levels, and to further show that the non-parametrically estimated transfer function fits this shape better than the linear prediction. From the scatterplots we can see that in general the observations are not monotonic, but instead are V-shaped. The graphs show that the non-parametric function fits the observations better than the linear prediction line because it fits this V shape better than a flat line. This is further reinforced by the information in Table 4.3, which shows that the predictive power of the reference function is consistently higher than that of the linear regression for every year of the sample.

Table 4.3 Predictive power of the transfer functions and F-test results, historic model.

Predictive power of:	2006		2007		2008		2009		2010	
Linear regression model	0.30		0.47		0.46		0.69		0.01	
Non-discriminatory transfer function	0.46		0.62		0.48		0.77		0.23	
Specific transfer function by farm type	0.58		0.69		0.59		0.80		0.38	
F-test:		*1% significance critical values of the F statistic*		*1% significance critical values of the F statistic*		*1% significance critical values of the F statistic*		*1% significance critical values of the F statistic*		*1% significance critical values of the F statistic*
Pre-transfer income effect for the linear model	205.36	7.20	406.80	7.15	371.82	7.27	1046.77	7.03	7.31	7.18
Linearity of the non-discriminatory function	46.34	4.24	47.83	3.87	7.19	4.35	68.34	4.50	47.54	4.65
Farm-type effects for the specific functions	4.26	1.80	3.45	1.84	4.41	1.91	2.27	1.86	4.26	1.95

Furthermore, using an F-test procedure (Cleveland and Devlin, 1988, p. 599), it was determined that the pre-transfer incomes are highly significant in the linear model, but the assumption of linearity is rejected in favour of the non-parametric specifications – the null of the linearity restrictions was rejected at 1% significance level in all years.

The kinked shape of the non-discriminatory non-parametric transfer function constitutes a very noticeable feature; the function is downward sloping for pre-support incomes below zero, and upward sloping for positive pre-support incomes. A downward sloping line represents progressivity in absolute terms, and an upward sloping line represents regressivity. This combination of both slopes means that the support works in a different manner depending on the value of pre-support incomes. The support is regressive, meaning it benefits richer farms more, for the range of farms which break even without the support. For farms in range of negative pre-support incomes, the support is highly progressive. Farms in that range are mainly livestock grazing farms, which would go out of business were it not for the provision of support, and even after provision of transfers, they remain barely profitable.

The graphs also include a breakeven line which plots the level of net transfers that farmers with negative pre-transfer incomes would need to receive in order to breakeven. The logic behind this is that for all the farms that generate negative pre-support incomes, the transfers need to be equal at least to the opposite of the pre-support incomes in order for the farm to break even. Thus the line demonstrates a certain type of sample selection for observations above it that would lead to a bias in the transfer function if it were estimated linearly. Farms which would suffer from very negative post-transfer incomes are simply not observed in the sample as they would have gone out of business, leaving those observations in the range of negative pre-transfer incomes that have post-transfer incomes close to zero – the support system keeps them in business. The fact that the transfer function roughly overlaps with the breakeven line (being slightly above it in most years) emphasises the role of support keeping the loss-generating farms in business for the range of negative pre-support incomes. There are some farms just below the line, and this represents the percentage of farms that make losses even after provision of support in any given year. However, farms which would consistently suffer losses or would be very far away from the breakeven line go out of business and are not observed in the dataset.

Panels B in Figures 4.1 – 4.5 repeat the non-discriminatory transfer functions from Panels A, but also show the farm type specific transfer functions. The purpose of this is to show the dispersion between the farm type specific functions around the non-discriminatory transfer functions, which will portray the degree of between-type horizontal inequality. Looking at the set of farm type specific transfer functions, one can clearly see the dispersion between the transfer functions for different farm types, which indicates the between-type inequality. Table 4.3 shows that the predictive power of farm specific functions is higher than that of non-discriminatory function. Furthermore, the F-test rejects the restrictions of no farm-type effects at 1% significance level in all years.

Table 4.4 shows the decomposition results for the actual policy regime across all sample years. Using the example of 2010, the absolute Gini index for pre-transfer income (A_X) was 18748, which is equal to half the average absolute difference between all distinct pairs of pre-support incomes in the sample. The corresponding value for post-transfer income (A_Y) is 23483. As can be seen, the difference between those two values, which represents the redistributive effect, is substantial. The average absolute difference between all pairs of incomes increases, which means that absolute inequality is higher with the support in place.

This pattern is repeated for all years: the redistributive effect was always negative and the provision of agricultural support increased the level of absolute income inequality – a result that is consistently statistically significant at 5% level. The percentage increase in inequality due to the agricultural support ranges between 13% in 2009 and 25% in 2010.

Table 4.4 Redistributive effect decomposition by year, historic model[28].

		2006	2007	2008	2009	2010
Absolute Gini index of post-transfer income	A_Y	**15449** ***	**17975** ***	**23900** ***	**24613** ***	**23483** ***
		693	*970*	*1087*	*1303*	*1081*
Absolute Gini index of farm type specific reference income	A_W	**10150** ***	**12939** ***	**18815** ***	**19828** ***	**17383** ***
		786	*1068*	*1163*	*1391*	*1184*
Absolute Gini index of non-discriminatory reference income	A_B	**8534** ***	**11004** ***	**17713** ***	**19038** ***	**16143** ***
		790	*1057*	*1157*	*1383*	*1254*
Absolute concentration index of non-discriminatory reference income (by start income)	$\bar{y}_B C_B$	**8506** ***	**10987** ***	**17712** ***	**19030** ***	**16112** ***
		841	1130	1176	1403	1308
Absolute Gini index of pre-transfer income	A_X	**12903** ***	**14455** ***	**20943** ***	**21688** ***	**18748** ***
		696	*979*	*1024*	*1294*	*915*
Index of redistributive effect	R	**-2546** ***	**-3520** ***	**-2957** ***	**-2924** ***	**-4735** ***
		695	*646*	*642*	*733*	*776*
Index of vertical redistribution	V	**4397** ***	**3468** ***	**3231** ***	**2659** ***	**2637** ***
		757	*810*	*718*	*761*	*958*
Disparity of net transfers	D	**0.11** ***	**0.09** ***	**0.08** ***	**0.06** ***	**0.06** ***
		0.02	*0.02*	*0.02*	*0.02*	*0.02*
Mean non-discriminatory transfers	$\bar{t}_B$	**39583** ***	**39311** ***	**39703** ***	**41615** ***	**47182** ***
		721	*768*	*900*	*785*	*952*
Disparity of net market price support		**-0.03**	**-0.03**	**0.07** **	**-0.02**	**0.02**
		0.03	*0.03*	*0.03*	*0.03*	*0.03*
Disparity of net Single Farm Payment		**0.12** ***	**0.08** ***	**0.02**	**0.03**	**0.03**
		0.02	*0.02*	*0.02*	*0.02*	*0.02*
Disparity of net other grants and subsidies		**0.23** ***	**0.24** ***	**0.30** ***	**0.28** ***	**0.17** ***
		0.03	*0.03*	*0.03*	*0.03*	*0.03*
Index of systematic reranking	H_R	**-28**	**-17**	**-1**	**-8**	**-31**
		351	*372*	*119*	*220*	*312*
Total classical horizontal inequality		**-6915** ***	**-6971** ***	**-6188** ***	**-5575** ***	**-7340** ***
		506	*543*	*544*	*451*	*607*
Of which:						
Between farm type	H_B	**-1616** ***	**-1935** ***	**-1102** **	**-791** **	**-1241** **
		477	*476*	*481*	*385*	*533*
Within farm type	H_W	**-5299** ***	**-5036** ***	**-5085** ***	**-4784** ***	**-6100** ***
		396	*407*	*439*	*368*	*445*

[28] For all tables, the results are in bold and the bootstrap standard errors are in small print under each value. Statistical significance at 1%, 5% and 10% are denoted respectively as ***, **, *.

However, the vertical stance of transfers, measured as the product of the progressivity of support D and the mean value of non-discriminatory transfer $\bar{t}_B$, is positive in all years; the result is also always statistically significant at the 1% level. This means that agricultural support is progressive in absolute terms, implying that poorer farmers get more than their equal share of non-discriminatory transfers. Such a finding might seem surprising given that CAP support under the historic model is linked to the historic levels of support, and through this to the historic volume of production. Given the structure of the industry has not changed much, one can expect this to mean that farms which are larger in terms of economic size will be getting more support. However, the reality of agricultural production in Scotland means that not all large farms (in terms of economic size units) generate high pre-transfer incomes. This is because many agricultural activities in Scotland would be loss-making in the absence of support, yet farmers continue to engage in these activities to qualify for support (Allanson, 2008). Accordingly, for some farm types gross support, transfers and non-discriminatory transfers are negatively correlated with pre-transfer incomes. The implications of this are such that the support often keeps loss-making farms of large economic size in business, which makes it more progressive. However, if the justification for support linked to the production size is to reward the most productive farmers, this is not realized with these loss-making farms which are highly dependant on support to remain in business.

The disparity index D is also calculated separately for different types of support: market price measures, the SFP and other grants and subsidies. The distribution of other grants and subsidies is the most progressive one among all sources of support, as indicated by the highest D index, and it is the only result consistently statistically significant. SFP distribution is also progressive, although less than other grants and subsidies, and the value of *D* is low and statistically insignificant in 2008 - 2010. The results for market price support are mixed and statistically insignificant, with the exception of 2008 when the progressivity of this type of support was the highest of all years and higher than for SFP.

In terms of specific examples to illustrate why overall the support is progressive in Scotland, large Cattle and Sheep farms are likely to have been making losses without support since meat production on LFA is a highly uncompetitive way to produce meat. While these farms are of smaller economic size than the average across farms, they receive higher values of support which keeps them in business. Furthermore, some of these farms that might be of large economic size will be receiving high values of transfers, but since they are loss-making, the pre-transfer incomes would be largely negative. This illustrated that there is no obvious story between the economic size of an enterprise and its profitability in Scotland, and that overall, the support the loss-making farms receive will contribute to the progressivity of support, even if their economic size is large – because their pre-support incomes are low.

As seen earlier, the shape of the non-parametric non-discriminatory transfer functions with the kink shows the line is downward sloping for farms with negative pre-support incomes, which means that the support is progressive for these farms. However, the slope of the function is upward sloping for positive pre-support incomes, which implies regressivity of support for this range. As such, the result of overall progressivity of the support in Scotland is driven by the progressivity in the range of negative pre-support incomes – where the farms are loss-making and the support keeps them in business.

The net result of negative redistributive effect in the presence of progressive transfers means that agricultural support would have reduced absolute income inequality if it were not for the presence of large horizontal inequalities, which offset the inequality-reducing impact of the vertical component. The magnitude of combined horizontal inequalities shows that net transfers could have been cut by between 7400 and 5600 pounds per farm in specific years without any impact on the level of welfare if a horizontally equitable system of provision was created, as measured by the Sen (1973) welfare function (see section 4.3.1). This financial measure indicates how important and costly the issue of horizontal inequalities is.

Classical horizontal inequalities make a very large contribution to the increase of absolute income differentials in the process of support distribution. Specifically, the within-type inequality is a lot bigger than the between-type one, accounting for between 72% and 86% of total classical HI. While the within-type inequality is measured by the dispersion of post-transfer incomes around the farm type income reference functions $h_W(\boldsymbol{x})$, the between-type inequality comes from systematic divergences between the non-discriminatory reference function $h_B(\boldsymbol{x})$ and the farm type ones $h_W(\boldsymbol{x})$. Both types of results are statistically significant at 5% level.

These results indicate some degree of discrimination in the provision of agricultural support between farm types, which is, perhaps not unexpected, given the commodity basis of the original CAP regime. Nevertheless, the dominant disequalizing role is played by within-type inequality which shows that factors other than farm type were most important in influencing the divergences in the value of support received by individual farms with specific level of pre-transfer incomes. Given the link of current support levels with historic support levels and therefore historic production volumes, and the assumption that structure of the industry has not changed much since the reference period, it can be implied that the factors which cause within-type inequality will be related to divergences in the production and income-generating capacity of farms. Research by the Scottish Government suggests that a large proportion of the variation in farms' income generating capacities is not explained by size differences, with other factors which influence it including: managerial ability, natural constraints, reasons for farming, attitudes towards environmental practices, farms fixed costs, interactions with other enterprises within the farm business and the nature of contracts with food retailers and suppliers (RESAS, 2012).

The systematic reranking component, while negative, is very small and does not contribute much to offsetting the progressivity of support; the result is consistently statistically insignificant at 10%. However, this does not mean that the provision of support did not result in substantial reranking of individuals in the income order. Instead it implies that, after accounting for the classical horizontal inequalities, there is no significant evidence that the provision of support generates income traps where some farmers with higher ranks in the pre-transfer incomes end up with lower ranks in the expected post-transfer incomes order. In all the analysed years, the reranking component accounts for less than 1% of all horizontal inequalities.

4.4.3.2 Flat rate scenario

Underlying the introduction of a flat national rate of SFP entitlement is a particular notion of procedural justice. Specifically, the common belief is that different entitlement values based on historic reference payments are becoming harder to justify and that the adoption of a flat rate model would therefore be fairer (Pack, 2010a). With the historic model, the entitlement values are very heterogeneous, and typically higher for farms that were more productive in the past, which meant they received higher values of coupled payments that subsequently served as the basis to calculate the value of the SFP entitlements. In this context, the introduction of the flat rate model would eliminate these historical anomalies but in the process create substantial redistribution of support from farms with currently higher value entitlements to farms with lower value entitlements. The redistributive implications of this scenario are discussed in this section by comparing actual outcomes over the period 2006-10 with what would have been observed if the flat rate model had been in place. Table 4.5 shows the weighted summary statistics of the flat rate regional model alternative distribution by years, and Table 4.6 shows the statistics by farm type.

The gross value of support is identical between the two scenarios (see Tables 4.5 and 4.1) for a given year, however, the net value of transfer varies, which is due to the difference in the net value of the SFP. This is caused by the earlier assumptions made about the passthrough of the SFP; it is full for farmers who own their land and 85% for tenant farmers. Alternative scenarios will distribute the payment differently between tenant farmers and those who own their land, which will result in a slightly different mean value of net SFP transfer.

Table 4.5 Weighted summary statistics by year, flat rate model.

	2006	2007	2008	2009	2010
Number of observations	474	458	443	479	484
Farm business size (ESU)	54	55	55	58	59
Post-transfer income (£)	31089	34057	44344	47274	48512
% of farms with post-transfer income<0	15%	13%	12%	11%	12%
Pre-transfer income (£)	-8320	-5065	4865	5850	1753
% of farms with pre-transfer income<0	68%	63%	51%	52%	54%
Gross support (£)	57913	57179	53337	54152	61299
Components:					
Market price support	18235	19210	13434	11689	13697
Single Payment Scheme	28496	29646	29235	33598	38563
Other grants and subsidies	11182	8323	10668	8864	9039
Net transfer to farmers (£)	39409	39123	39479	41424	46759
Components:					
Market price support	6354	6467	4890	4225	4948
Single Payment Scheme	26779	27857	27511	31721	36190
Other grants and subsidies	6276	4799	7078	5478	5620
Net support as % of post-support income	127%	115%	89%	88%	96%

Table 4.6 Weighted summary statistics by farm type, flat rate model.

	All	*Cereal*	*General Cropping*	*Dairy*	*Specialist Sheep*	*Specialist Cattle*	*Cattle & Sheep*	*Mixed*
Number of observations	468	66	46	58	41	121	70	65
Farm business size (ESU)	56	62	104	103	15	39	42	58
Post-transfer income (£)	41055	29568	44560	49387	64015	23664	64277	27877
% of farms with post-transfer income<0	13%	18%	11%	11%	2%	17%	7%	18%
Pre-transfer income (£)	-184	10926	22690	21396	-6245	-14018	-11453	-4267
% of farms with pre-transfer income<0	58%	36%	35%	31%	68%	76%	72%	59%
Gross support (£)	56776	21393	30392	47321	78098	58408	101531	50039
Components:								
Market price support	15253	1694	9032	28873	5904	19983	18706	20005
Single Payment Scheme	31908	17536	18477	14862	61725	23734	65065	21910
Other grants and subsidies	9615	2163	2883	3585	10469	14691	17760	8123
Net transfer to farmers (£)	41239	18642	21870	27990	70260	37682	75731	32144
Components:								
Market price support	5377	473	2691	11256	3940	6578	6129	6289
Single Payment Scheme	30012	16770	17403	14488	58419	22353	60077	20742
Other grants and subsidies	5850	1399	1776	2246	7901	8752	9525	5113
Net support as % of post-support income	103%	78%	57%	61%	110%	166%	119%	121%

The share of farms with negative post-support income is consistently higher by a few percentage points with the flat rate compared to the historic model. This implies the redistribution of support under flat rate would impact negatively some of the farms that make pre-support losses by reducing their support levels, and consequently these farms would not break even with the support in place.

Comparing the summary statistics by farm type in Table 4.6 with the results from actual distribution in Table 4.2 reveals more information on the winners and losers of the redistribution under the flat rate model, which makes some farm types better off and others worse off. These results should be interpreted bearing in mind that they concern only the average impact within each farm type, and in reality some variation within each type exists. All farm types but two lose out under the redistribution; Specialist Sheep and Cattle & Sheep farms are the big beneficiaries, whose average values of (net) SFP transfers increase by a staggering 250% and 90%, respectively. Specialist Cereal, General Cropping, Dairy and Mixed farms on average suffer similar losses, with the drop in the average value of net SFP transfer in the proximity of 50%. Also Specialist Cattle farms lose out under the flat rate, but with a smaller average reduction in the net value of SFP transfers of 30%. All of the farm types that suffer a reduction in average SFP transfers under the flat rate model also experience a substantial increase in the percentage of farms making post-support losses.

Table 4.7 Weighted summary of entitlement value and quantity by farm type, historic model.

Farm type	*Variable*	*Observations*	*Mean*	*Std. Dev.*	*Minimum*	*Maximum*
Specialist Cereal	*Entitlement value*	331	244.9	58.4	120.4	493.6
	Quantity of entitlements	331	132.9	71.8	14.0	400.1
General Cropping	*Entitlement value*	232	233.4	45.5	91.2	386.6
	Quantity of entitlements	232	141.3	136.3	11.4	1986.0
Dairy	*Entitlement value*	290	240.8	103.4	58.9	787.3
	Quantity of entitlements	290	125.2	68.9	28.0	822.9
Specialist Sheep	*Entitlement value*	203	73.2	67.1	4.5	237.9
	Quantity of entitlements	203	537.7	612.3	47.6	6472.0
Specialist Cattle	*Entitlement value*	605	191.9	76.7	18.5	501.8
	Quantity of entitlements	605	202.3	247.3	19.7	2641.3
Specialist Cattle & Sheep	*Entitlement value*	346	117.1	77.3	5.3	460.6
	Quantity of entitlements	346	560.8	989.9	0.0	7904.9
Mixed	*Entitlement value*	327	253.3	123.3	18.2	1681.9
	Quantity of entitlements	327	180.0	197.0	16.8	2197.8
Flat rate entitlement value:	104.4					

In general, the expectation is that the flat rate model would benefit LFA farms (mostly livestock grazing), where the reference payments were lower (due to lower stocking rates) and thus the values of entitlements are lower. Thus averaging out the entitlements with more productive farm types (mostly on non-LFA land) should increase the SFP entitlement values on LFA farms. However, the results indicate that Specialist Cattle farms, which are mostly LFA holdings, also lose out under the flat rate model. More insight into why this is the case can be gained from Table 4.7 which shows the (weighted) mean values of SFP entitlements and quantities of entitlements per farm for different farm types under the actual distribution.

As can be seen, the value of entitlements for Sheep and Cattle & Sheep farms are on average much lower than for other farm types, but their quantity is very high, reflecting the fact they are very large holdings in terms of eligible land area. At the same time, Cattle farms on average have higher value of entitlements and less of them (roughly comparable to other farm types in terms of number of hectares, and hence number of entitlements). Thus when the entitlement values are averaged across Scotland under the flat rate model, large Sheep and Cattle & Sheep farms benefit a lot because their entitlement values increase[29]. However, this happens at a cost to all other farm types, including Cattle farms (which lose relatively less compared to other disadvantaged farm types as their average entitlements are slightly lower).

Table 4.8 shows the results of the redistributive effect decomposition for the flat rate scenario (where the pre-support incomes for historic and flat rate scenarios are identical). It can be seen that the redistributive effect is more negative than with the

[29] The cited flat rate value of entitlement is in fact lower than the average historic entitlement value for Specialist Cattle & Sheep farms. However, they still gain from the flat rate scenario on average, which suggests that many farms in this type currently have entitlements values lower than the flat rate of 104.4, and the gains these farms make outweigh the losses of farms with historic entitlement values above 104.4. Presumably, the higher the share of sheep production to cattle production on the farm, the lower the entitlement value.

actual distribution in Table 4.4, which means that the flat rate regional model increases absolute income inequality more than the historic model. Further inspection into the redistributive effect components reveals a number of interesting points.

First of all, the flat rate model would result in greater vertical redistribution *V* for all years compared to the historic model. With broadly similar mean transfer values for both scenarios, this effect is entirely due to the difference in the disparity index *D*, which means that the flat rate distribution model results in more progressive distribution of support. This result is statistically significant at 1% level for all years, with the exception of 2010. Introduction of the regional model would cut the link between the historic volumes of production and the values of entitlements, and this would cause a redistribution of support from farms that were more productive in the past and hence had higher values of coupled payments in the historic reference period, to less productive farms with lower value of reference payments. Consequently, a flat rate support would generate higher transfer values for some poorer farms and this leads to the result of higher progressivity. However, taking into account the summary statistics by farm type, this result is driven by the gains experienced by Specialist Sheep and Cattle & Sheep farms, since all other farm types lose out on average. Furthermore, in spite of the overall increase in progressivity, some of the farms that lose out under this scenario are farms which make pre-support losses, seeing that the percentage of farms with post-support losses increases compared to the historic model. This implies that under flat rate, the levels of payments do not reflect the levels of disadvantage among farms that make losses in the absence of support as well as under the historic model, where more pre-support loss making farms broke even with the help of support.

A second point revealed by this part of the analysis is the sharp increase in classical horizontal inequalities under the flat rate model; in particular, the between-type component is a lot larger than under the current historical payment model. While within-type inequality increases somewhat under the flat rate model, the between-type component increased by between 3.5 and 7.7 times (where the level of between-type inequality is statistically significant across all the years). Whereas with the historic model the between-type inequality is relatively small, these results indicate that under the regional model there would be a sharp increase in discrimination between different types of farms. To understand this result, one needs to think about the nature of the CAP. The coupled payments replaced by SFP were determined by historic levels of production where the level of support will have been calibrated to some extent to the relative profitability of different enterprises so as to make all commodities comparably profitable, at least at the margin, with the support in place. If this had not been the case then farmers would have switched production to those commodities that were more profitable, resulting in excess supply of some products and underproduction of others. The switch to coupled payments first and then to the historic SFP model maintained that balance to some extent, hence relatively little between-type discrimination occurred under the latter model of distribution. However, if the SPS mechanism was changed to the flat-rate regional model, this link would be cut, and discrimination between farm types would significantly increase.

The impact of systematic reranking is slightly higher with the flat rate model, but the magnitude of it still remains low in relation to other components (and consistently statistically insignificant). This indicates that introducing the regional model would not create a system with income traps, whereby farmers higher up in the ranks of pre-support income would systematically end up lower on the income ladder after the provision of support.

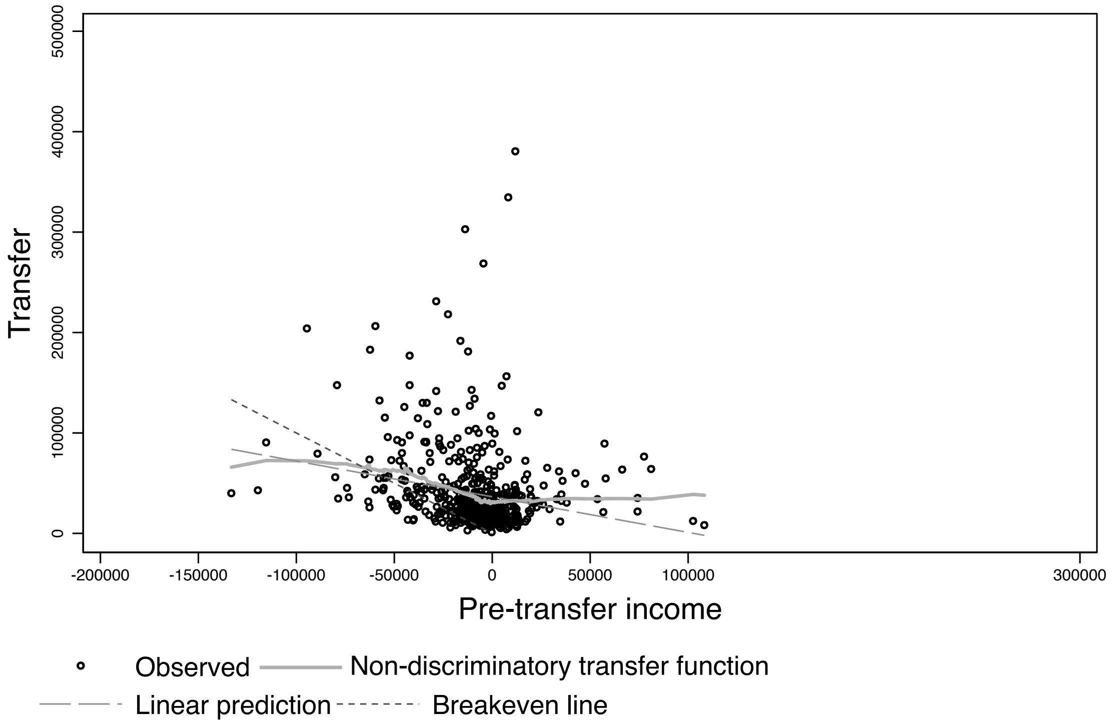
Table 4.8 Redistributive effect decomposition by year, flat rate model.

		2006	2007	2008	2009	2010
Absolute Gini index of post-transfer income	$\boxed{A_Y}$	**20842** ***	**21908** ***	**26732** ***	**28945** ***	**31452** ***
		1480	*1603*	*1722*	*2013*	*2357*
Absolute Gini index of farm type specific reference income	$\boxed{A_W}$	**14761** ***	**16050** ***	**20666** ***	**22341** ***	**24383** ***
		1476	*1794*	*1812*	*1963*	*2591*
Absolute Gini index of non-discriminatory reference income	$\boxed{A_B}$	**8136** ***	**9307** ***	**13822** ***	**16260** ***	**15730** ***
		1169	*1303*	*1362*	*1685*	*2040*
Absolute concentration index of non-discriminatory reference income (by start income)	$\boxed{\bar{y}_B C_B}$	**8104** ***	**9109** ***	**13792** ***	**16132** ***	**15725** ***
		1421	1468	1510	1759	1941
Absolute Gini index of pre-transfer income	$\boxed{A_X}$	**12903** ***	**14455** ***	**20943** ***	**21688** ***	**18748** ***
		689	*867*	*1002*	*1223*	*934*
Index of redistributive effect	$\boxed{R}$	**-7939** ***	**-7453** ***	**-5789** ***	**-7257** ***	**-12704** ***
		1496	*1462*	*1508*	*1769*	*2320*
Index of vertical redistribution	$\boxed{V}$	**4799** ***	**5346** ***	**7151** ***	**5556** ***	**3024**
		1291	*1249*	*1189*	*1350*	*1841*
Disparity of net transfers	$\boxed{D}$	**0.12** ***	**0.14** ***	**0.18** ***	**0.13** ***	**0.07**
		0.03	*0.03*	*0.03*	*0.03*	*0.04*
Mean non-discriminatory transfers	$\boxed{\bar{t}_B}$	**39409** ***	**39123** ***	**39479** ***	**41424** ***	**46759** ***
		1692	*1796*	*2011*	*2002*	*2426*
Disparity of net market price support		**-0.03**	**-0.03**	**0.07** **	**-0.02**	**0.02**
		0.03	*0.03*	*0.03*	*0.03*	*0.03*
Disparity of net Single Farm Payment		**0.15** ***	**0.16** ***	**0.16** ***	**0.15** ***	**0.03**
		0.04	*0.04*	*0.03*	*0.04*	*0.04*
Disparity of net other grants and subsidies		**0.23** ***	**0.24** ***	**0.30** ***	**0.28** ***	**0.17** ***
		0.03	*0.03*	*0.03*	*0.03*	*0.03*
Index of systematic reranking	$\boxed{H_R}$	**-32**	**-198**	**-29**	**-128**	**-6**
		1318	*1613*	*976*	*1376*	*702*
Total classical horizontal inequality		**-12706** ***	**-12601** ***	**-12911** ***	**-12685** ***	**-15722** ***
		1343	*1183*	*1491*	*1567*	*1532*
Of which:						
Between farm type	$\boxed{H_B}$	**-6625** ***	**-6743** ***	**-6844** ***	**-6080** ***	**-8652** ***
		1147	*1270*	*1504*	*1318*	*1626*
Within farm type	$\boxed{H_W}$	**-6082** ***	**-5858** ***	**-6066** ***	**-6605** ***	**-7070** ***
		747	*747*	*809*	*1006*	*989*

Figures 4.6 - 4.10 plot the non-discriminatory and farm-type specific transfer functions under the flat rate model. As in the comparable figures for the historic model, Panel A depicts the non-discriminatory transfer functions and Panel B the farm type specific transfer functions.

Figure 4.6 Non-discriminatory transfer function and farm type specific functions, flat rate, 2006.

Panel A



Panel B

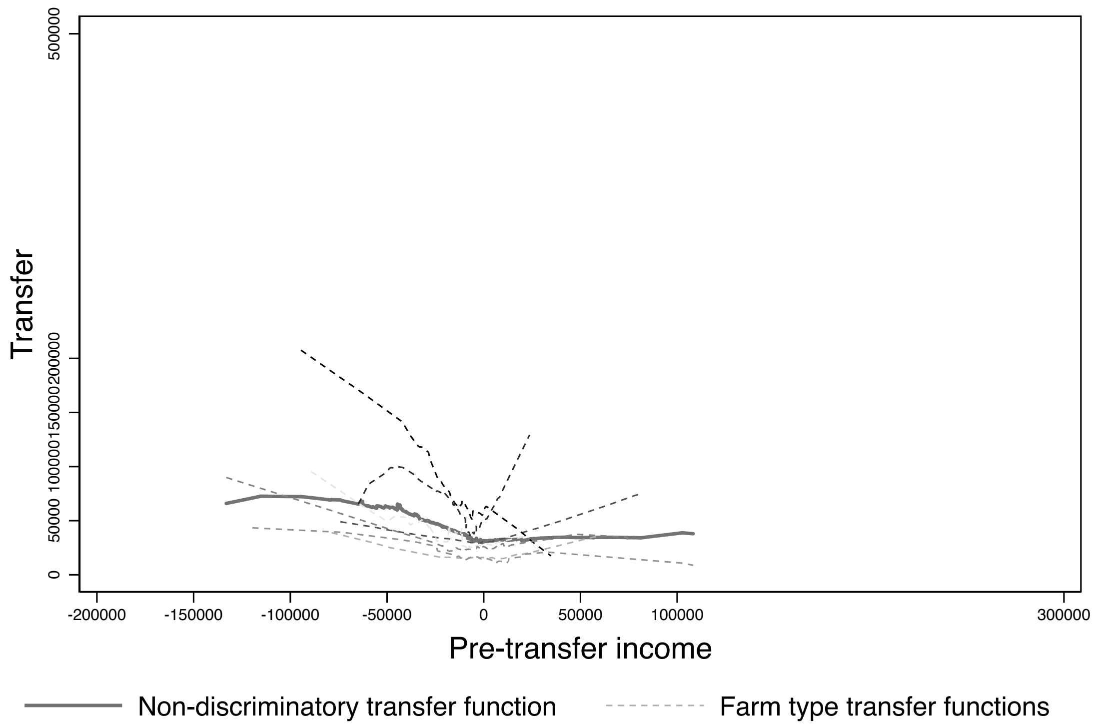
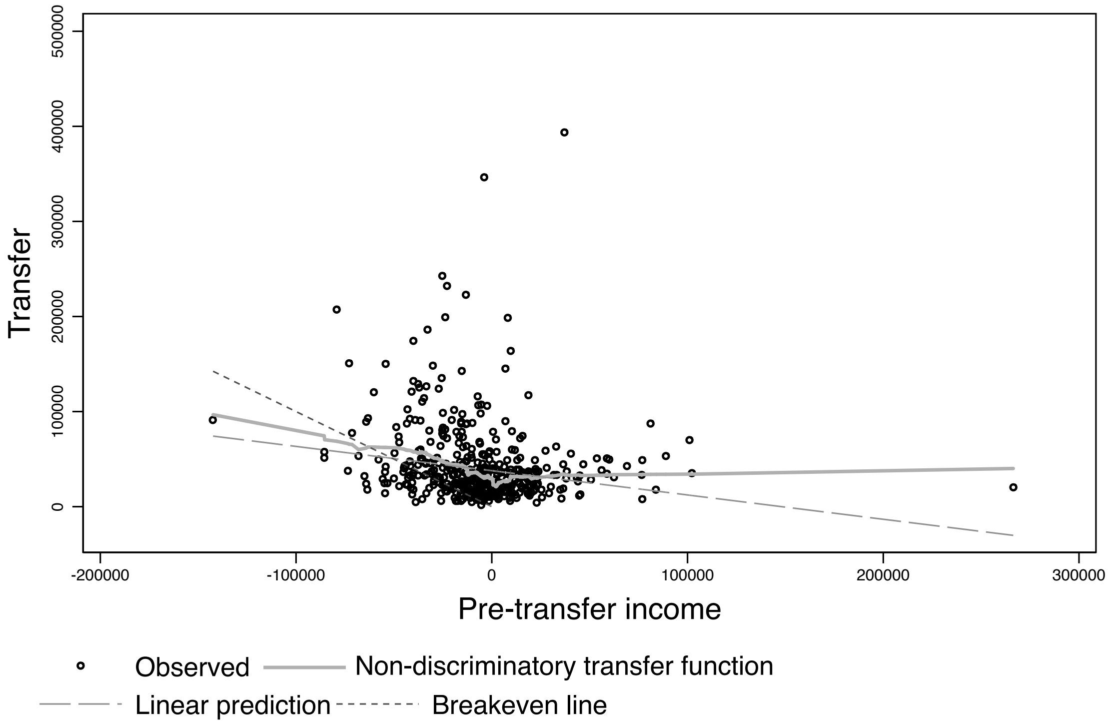


Figure 4.7 Non-discriminatory transfer function and farm type specific functions, flat rate, 2007.

Panel A



Panel B

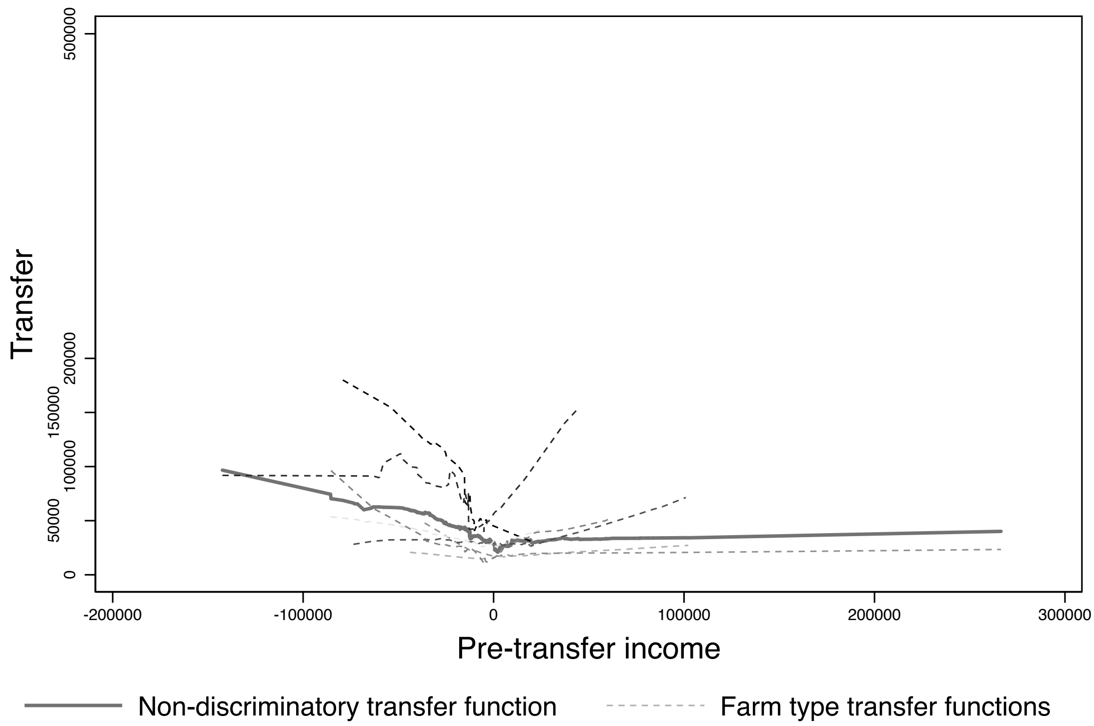
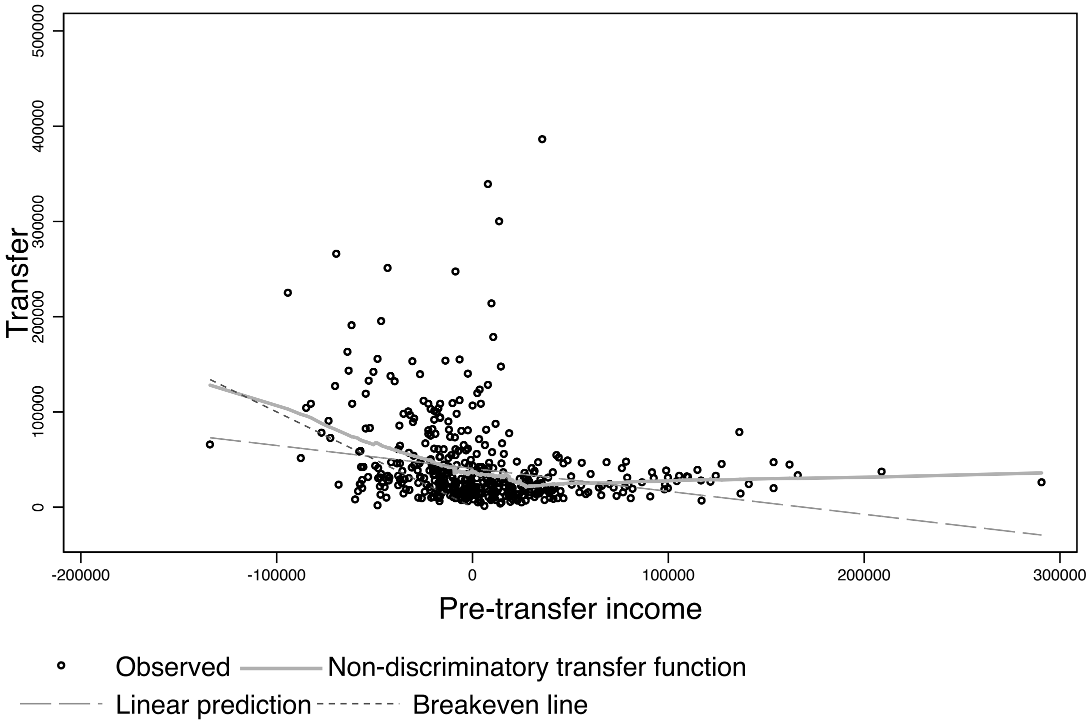


Figure 4.8 Non-discriminatory transfer function and farm type specific functions, flat rate, 2008.

Panel A



Panel B

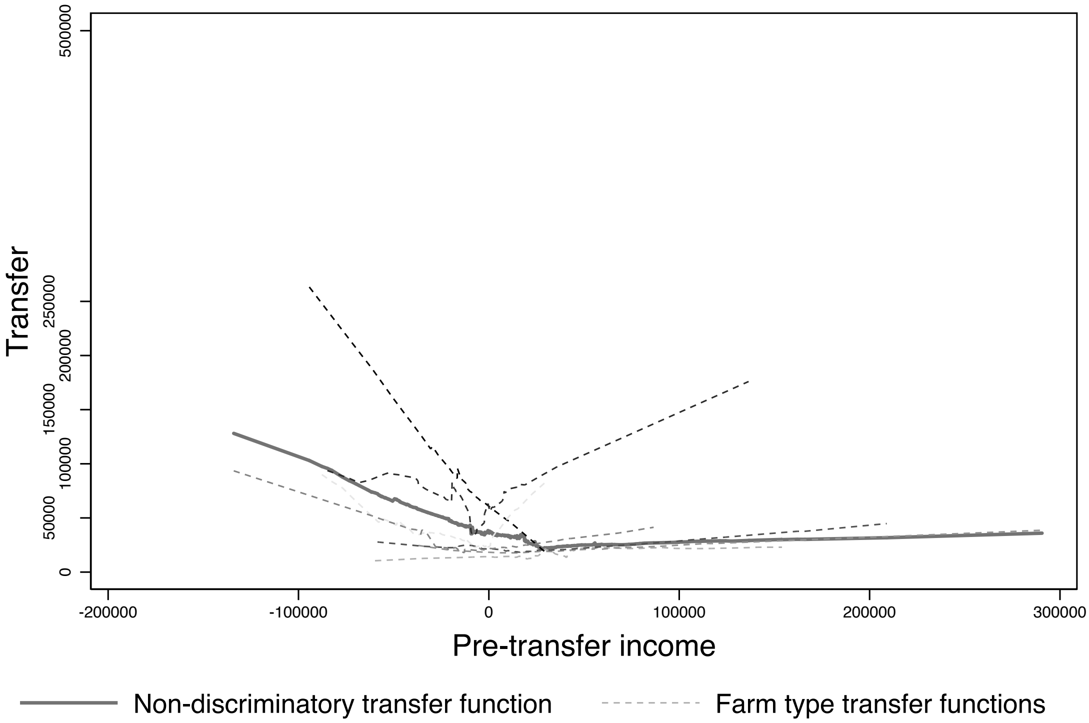
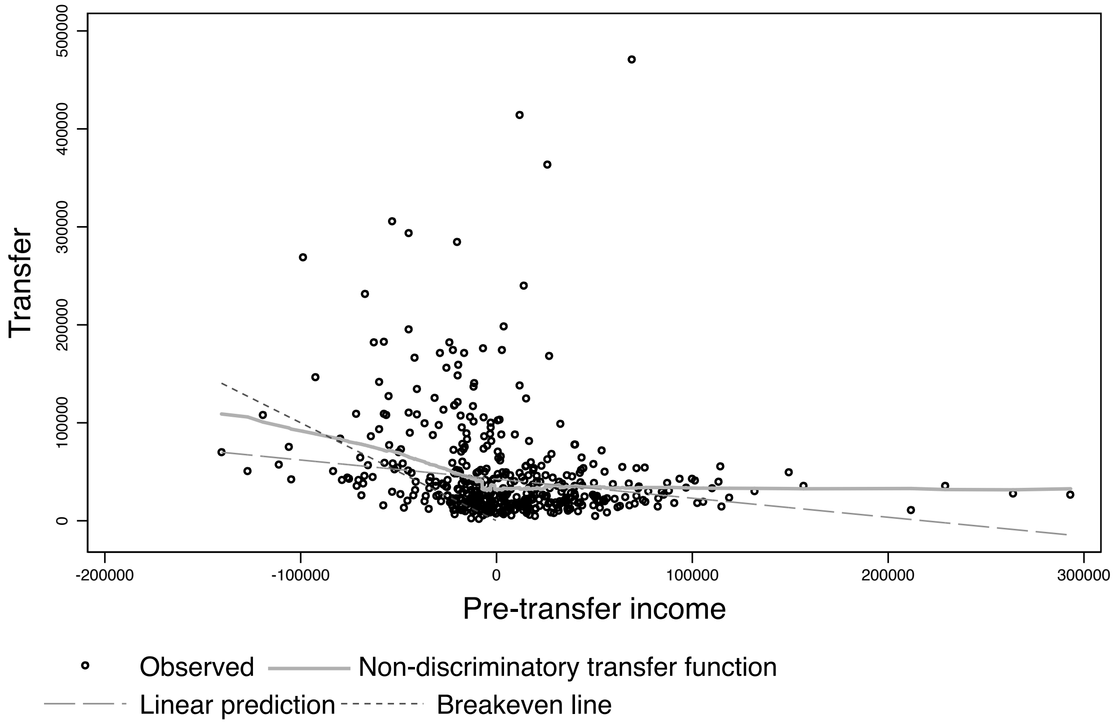


Figure 4.9 Non-discriminatory transfer function and farm type specific functions, flat rate, 2009.

Panel A



Panel B

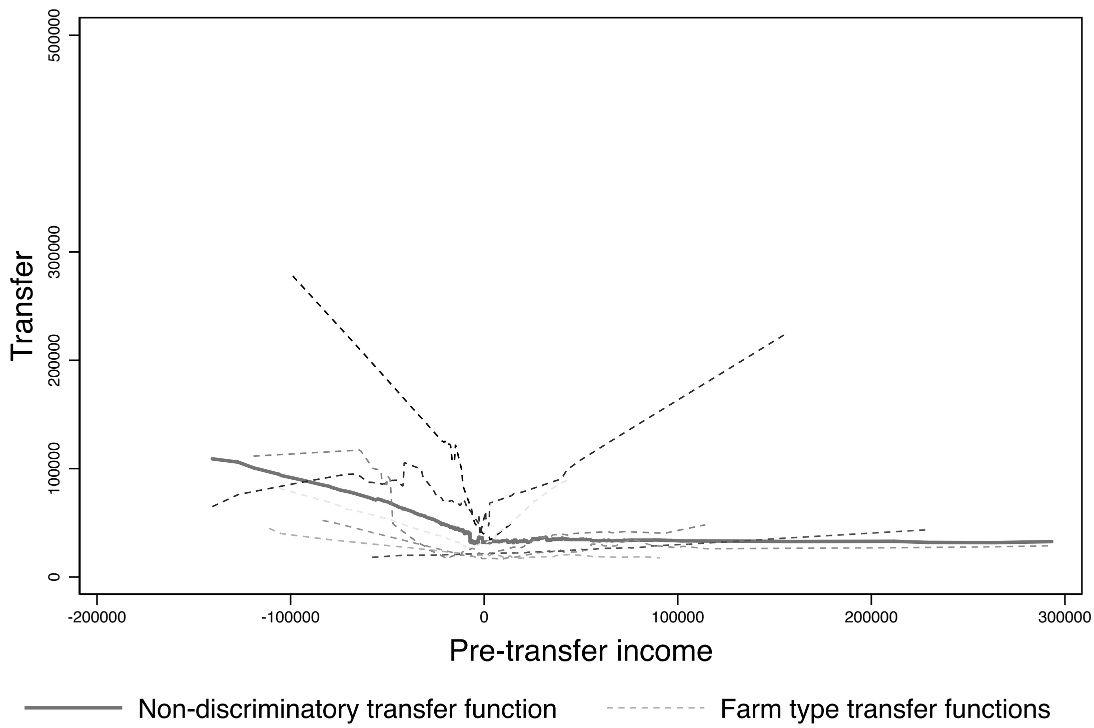
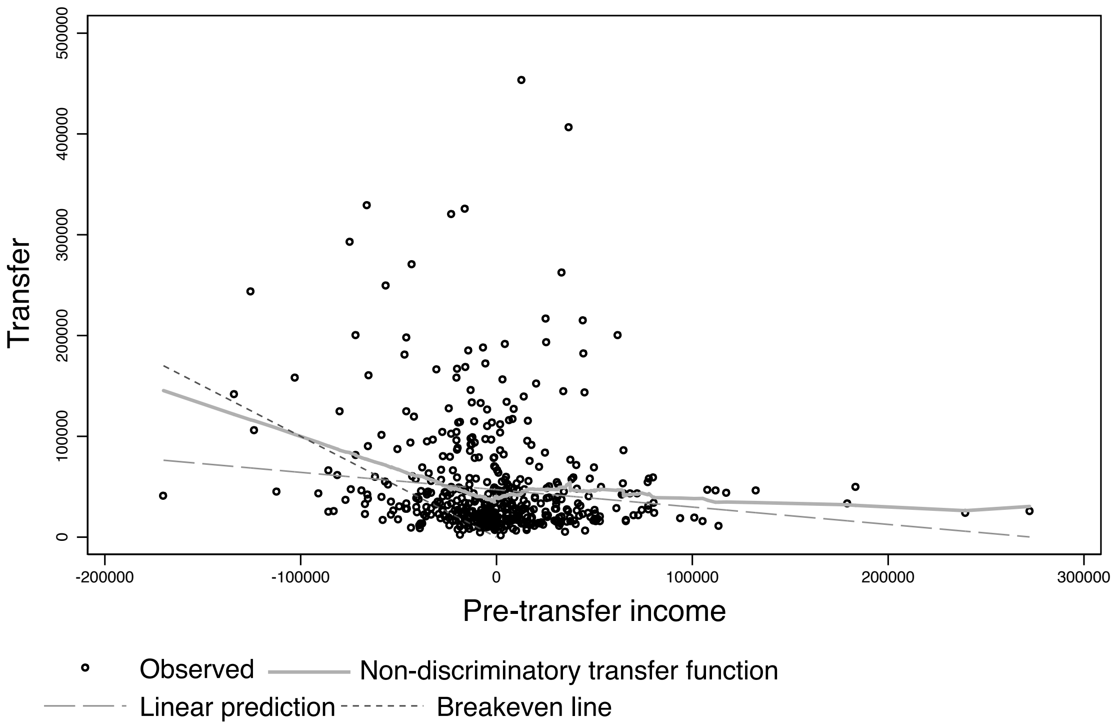
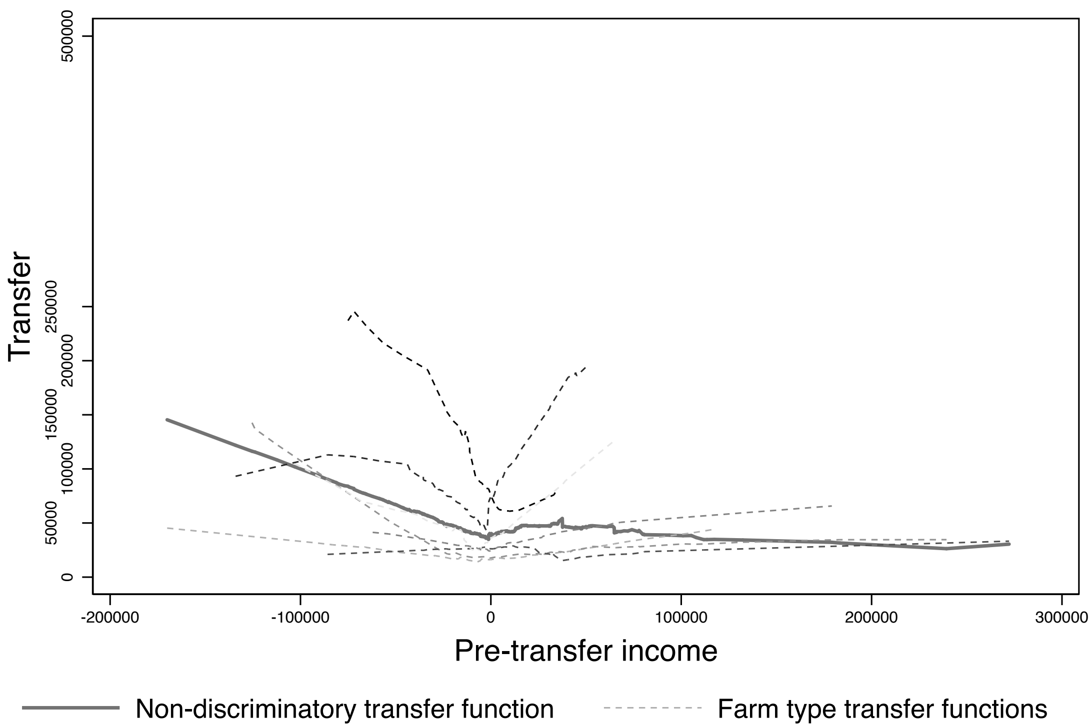


Figure 4.10 Non-discriminatory transfer function and farm type specific functions, flat rate, 2010.

Panel A



Panel B



The graphs reveal some interesting points about the result of increased progressivity under regional model. Comparing Panel A's in the two sets of graphs, the non-parametric line is a lot flatter for positive pre-transfer incomes under the flat-rate model. While the kink in the function still exists, the V shape is less pronounced because of this flattening, which means that the result of increased progressivity with the flat rate is largely driven by the reduction of the regressivity of support in the range of positive pre-support incomes. The slope of the non-parametric function for the range of negative pre-support incomes is also flatter under the flat rate than with historic model. This reflects the negative impact on the farms which make pre-support losses and stand to lose under the flat rate model, and in particular on the farms with very large pre-support losses, as transfer levels received by them in any given year will strongly influence the slope of the function.

Inspection of farms with largest pre-support losses in all the years reveals that this is quite a mixed group; there are farms of all types, but with relatively few sheep holdings. Therefore most of the farms with the largest pre-support losses see a drop in transfer levels under the flat rate model. As such, while overall the introduction of the flat rate increases the progressivity of support, at the same time it makes some of the farms that would make the largest losses in the absence of support worse off. This is further reflected in the increase in the number of farms below the breakeven line compared to the historic model; not only there are more of them, but many are located further away from the breakeven line, which means the scale of their post-support losses is larger.

Comparing the Panel B's in Figures 4.6 – 4.10 with those on Figures 4.1 – 4.5 reveals a marked increase in the dispersion of the farm-type specific functions under the flat rate model. This reflects the increase in between-type discrimination. The two farm types that are most displaced from the non-discriminatory transfer function are Specialist Sheep and Cattle & Sheep, the big beneficiaries under the flat rate model; the large increase in between-type inequality is to a large extent driven by the gains of these two farm types at the cost of all other types.

4.4.3.3 LFA/non-LFA scenario

The introduction of two different rates of entitlements, one for LFA farms and the other for non-LFA farms, has been proposed as a way to mitigate the extent of redistribution of support that would otherwise arise under the flat rate, since in general LFA holdings have higher value of entitlements than non-LFA holdings (Pack, 2010b). As such, the LFA/non-LFA model represents a sort of intermediate solution between the historic and the flat rate models. The redistributive implications of the split rate scenario are discussed in this section.

Table 4.9 shows the weighted summary statistics of the LFA/non-LFA regional model distribution by years, and Table 4.10 shows the statistics by farm type. In addition, Table 4.11 presents the (weighted) mean values of SFP entitlements and quantities of entitlements per farm for different farm types under the actual distribution, but unlike earlier in Table 4.7, within each farm type, the farms are split into the LFA and non-LFA holdings. Information from this table will be helpful for the interpretation of the redistribution results that follows.

Table 4.9 Weighted summary statistics by year, LFA/non-LFA model.

	2006	2007	2008	2009	2010
Number of observations	474	458	443	479	484
Farm business size (ESU)	54	55	55	58	59
Post-transfer income (£)	31146	34062	44388	47299	48558
% of farms with post-transfer income<0	12%	12%	12%	12%	8%
Pre-transfer income (£)	-8320	-5065	4865	5850	1753
% of farms with pre-transfer income<0	68%	63%	51%	52%	54%
Gross support (£)	57913	57179	53337	54152	61299
Components:					
Market price support	18235	19210	13434	11689	13697
Single Payment Scheme	28496	29646	29235	33598	38563
Other grants and subsidies	11182	8323	10668	8864	9039
Net transfer to farmers (£)	39466	39128	39523	41449	46805
Components:					
Market price support	6354	6467	4890	4225	4948
Single Payment Scheme	26836	27862	27555	31747	36236
Other grants and subsidies	6276	4799	7078	5478	5620
Net support as % of post-support income	127%	115%	89%	88%	96%

As can be seen, with the LFA/non-LFA model the percentage of farms with negative post-support income is larger than with the historic model. However, the negative impact of the regional model on the farms which make pre-support losses is slightly mitigated with the LFA/non-LFA scenario compared to the flat rate one; the percentage of farms with losses after the provision of support is smaller in 3 out of the 5 years compared to the flat rate scenario and broadly similar in the other two.

Comparing the net SFP transfers by farm type to the values under the historic and flat rate models reveals that Specialist Sheep and Sheep & Cattle farms are still the biggest beneficiaries of the redistribution of support; their gains are not as large as with the flat rate, but still substantial, with the average net SFP transfer levels increasing by around 170% and 50% respectively, compared to the historic model.

Table 4.10 Weighted summary statistics by farm type, LFA/non-LFA model.

	All	*Cereal*	*General Cropping*	*Dairy*	*Specialist Sheep*	*Specialist Cattle*	*Cattle & Sheep*	*Mixed*
Number of observations	468	66	46	58	41	121	70	65
Farm business size (ESU)	56	62	104	103	15	39	42	58
Post-transfer income (£)	41091	43688	59589	50650	50657	19847	53242	32077
% of farms with post-transfer income<0	11%	12%	4%	9%	2%	19%	8%	16%
Pre-transfer income (£)	-184	10926	22690	21396	-6245	-14018	-11453	-4267
% of farms with pre-transfer income<0	58%	36%	35%	31%	68%	76%	72%	59%
Gross support (£)	56776	36143	46395	48579	63981	54393	89588	54592
Components:								
Market price support	15253	1694	9032	28873	5904	19983	18706	20005
Single Payment Scheme	31908	32286	34479	16120	47608	19719	53121	26463
Other grants and subsidies	9615	2163	2883	3585	10469	14691	17760	8123
Net transfer to farmers (£)	41274	32762	36899	29253	56902	33865	64696	36343
Components:								
Market price support	5377	473	2691	11256	3940	6578	6129	6289
Single Payment Scheme	30047	30889	32432	15752	45061	18535	49042	24942
Other grants and subsidies	5850	1399	1776	2246	7901	8752	9525	5113
Net support as % of post-support income	103%	82%	67%	62%	113%	178%	123%	118%

For General Cropping farms the average value of transfers with the split rate of entitlements is almost identical to the level with the historic model. The remaining farm types still suffer losses in relation to the distribution with the historic model, but for Specialist Cereal, Dairy and Mixed farms, these losses are smaller than in the flat rate scenario. For Specialist Cereal, the extent of losses is mitigated substantially, since the reduction in the average SFP transfer value relative to the historic model is only 7%, compared to almost 50% with the flat rate. This mitigation in the extent of redistribution for Specialist Cereal and General Cropping farms reflects the fact that these farms are mostly on non-LFA land (as shown by Table 4.11); averaging rates between LFA and non-LFA holdings means that most of the farms within these two types enjoy support levels comparable to those under the historic model.

Table 4.11 Weighted summary of entitlement value and quantity by farm type & LFA status, historic model.

Farm type	*Variable*	*Observations*	*Mean*	*Std. Dev.*	*Minimum*	*Maximum*
Specialist Cereal, LFA	*Entitlement value*	24	280.0	72.7	168.6	493.6
	Quantity of entitlements	24	125.5	70.9	14.0	324.3
Specialist Cereal, non-LFA	*Entitlement value*	307	241.9	56.1	120.4	480.3
	Quantity of entitlements	307	133.5	71.9	31.8	400.1
General Cropping, LFA	*Entitlement value*	9	189.3	55.1	91.2	295.2
	Quantity of entitlements	9	228.5	182.0	38.3	503.9
General Cropping, non-LFA	*Entitlement value*	223	235.0	44.5	91.4	386.6
	Quantity of entitlements	223	138.2	133.8	11.4	1986.0
Dairy, LFA	*Entitlement value*	205	230.9	105.9	58.9	787.3
	Quantity of entitlements	205	132.7	71.8	28.0	822.9
Dairy, non-LFA	*Entitlement value*	85	264.3	93.3	67.2	552.8
	Quantity of entitlements	85	107.5	58.3	30.4	370.3
Specialist Sheep, LFA	*Entitlement value*	202	72.1	66.1	4.5	237.9
	Quantity of entitlements	202	541.2	613.1	58.7	6472.0
Specialist Sheep, non-LFA	*Entitlement value*	1	228.9	.	228.9	228.9
	Quantity of entitlements	1	47.6	.	47.6	47.6
Specialist Beef, LFA	*Entitlement value*	564	186.9	73.4	18.5	474.9
	Quantity of entitlements	564	208.7	254.1	31.5	2641.3
Specialist Beef, non-LFA	*Entitlement value*	41	252.1	90.1	119.7	501.8
	Quantity of entitlements	41	125.6	120.3	19.7	874.6
Mixed Cattle & Sheep, LFA	*Entitlement value*	319	105.0	71.7	5.3	460.6
	Quantity of entitlements	319	612.0	1038.0	0.0	7904.9
Mixed Cattle & Sheep, non-LFA	*Entitlement value*	27	207.6	54.9	67.6	312.5
	Quantity of entitlements	27	170.1	256.9	19.7	885.8
Mixed, LFA	*Entitlement value*	172	227.2	72.9	18.2	451.4
	Quantity of entitlements	172	219.9	252.6	41.7	2197.8
Mixed, non-LFA	*Entitlement value*	155	283.3	158.1	91.3	1681.9
	Quantity of entitlements	155	134.0	78.9	16.8	500.2
LFA entitlement value:	226.9					
Non-LFA entitlement value:	81.6					

The story is different with Dairy, Mixed and Specialist Cattle farms. As Table 4.11 shows, among these three types, many farms are LFA holdings, but the average value of entitlements on these LFA farms is substantially higher than for Specialist Sheep and Cattle & Sheep LFA farms. As such, the LFA Dairy, Mixed and Specialist Cattle farms would be worse off with the split rate rather than the flat rate model, since their historical entitlement values would be averaged with LFA Specialist Sheep and Cattle & Sheep farms only, without the inclusion of non-LFA farms to bring the average value up as under the flat rate model. Taking this into consideration, the impact of the split rate model on the average SFP transfer level in Table 4.10 will depend on the ratio of LFA to non-LFA farms within a given type. For Dairy and Mixed farms this ratio is low enough such that the reduction in average transfer levels compared to the historic model is smaller than under the flat rate model as a result of the gains experienced by non-LFA Dairy and Mixed farms. However, Specialist Cattle farms are mostly LFA holdings, thus the losses made by the LFA cattle farms more than offset the gains experienced by the few non-LFA Specialist Cattle farms. Consequently, the average SFP transfer received by Specialist Cattle farms under the split rate model is lower compared to the flat rate one.

Table 4.12 shows the results of the redistributive effect decomposition for the LFA/non-LFA scenario. In all years, the overall redistributive effect is more negative than with the historic model, but less negative than with the flat rate; this reflects the intermediate nature of this model.

The LFA/non-LFA model is not as progressive as the flat rate. The disparity index *D* is higher than under the actual programme for only 3 out of the 5 years (and the increase is not as big as under the flat rate scenario), and it is in fact lower for 2 remaining years, which means that the impact of this model on progressivity of support is somewhat ambiguous. The vertical redistribution index is statistically significant at 1% level for all years, with the exception of 2010.

The LFA/non-LFA rates still cut the link to the historic value of support, but in a different way, allowing for the distinction between better and worse quality of land, where payment rates per hectare were traditionally higher on better quality non-LFA land; this differentiation of entitlement rates reduces the level of redistribution compared to the flat rate model. The earlier discussion of losers and winners under the split rate scenario showed that LFA Sheep and Cattle & Sheep farms would see an average increase in transfer values with this model, while all other LFA farms would suffer a reduction in their entitlement values. This suggests that in 2006 and 2010 when the split rate model is less progressive than the historic one, the negative impact on the farms that lose with split rates outweighs the positive impact on farms that would see their transfer levels increase.

Table 4.12 Redistributive effect decomposition by year, LFA/non-LFA model.

		2006		2007		2008		2009		2010	
Absolute Gini index of post-transfer income	A_Y	**18558**	***	**20416**	***	**26503**	***	**27881**	***	**29329**	***
		1235		*1392*		*1389*		*1726*		*1926*	
Absolute Gini index of farm type specific reference income	A_W	**12243**	***	**14863**	***	**20881**	***	**21432**	***	**22090**	***
		1225		*1568*		*1501*		*1702*		*2051*	
Absolute Gini index of non-discriminatory reference income	A_B	**9289**	***	**10499**	***	**17447**	***	**18138**	***	**16634**	***
		995		*1200*		*1300*		*1578*		*1637*	
Absolute concentration index of non-discriminatory reference income (by start income)	$\bar{y}_B C_B$	**9273**	***	**10434**	***	**17440**	***	**18134**	***	**16621**	***
		1107		1334		1450		1719		1792	
Absolute Gini index of pre-transfer income	A_X	**12903**	***	**14455**	***	**20943**	***	**21688**	***	**18748**	***
		701		*906*		*1010*		*1241*		*916*	
Index of redistributive effect	R	**-5655**	***	**-5960**	***	**-5560**	***	**-6193**	***	**-10580**	***
		1209		*1219*		*1112*		*1361*		*1801*	
Index of vertical redistribution	V	**3631**	***	**4021**	***	**3503**	***	**3555**	***	**2127**	
		991		*1041*		*1029*		*1106*		*1696*	
Disparity of net transfers	D	**0.09**	***	**0.10**	***	**0.09**	***	**0.09**	***	**0.05**	
		0.02		*0.03*		*0.02*		*0.03*		*0.04*	
Mean non-discriminatory transfers	$\bar{t}_B$	**39466**	***	**39128**	***	**39523**	***	**41449**	***	**46805**	***
		1347		*1501*		*1625*		*1629*		*2050*	
Disparity of net market price support		**-0.03**		**-0.03**		**0.07**	**	**-0.02**		**0.02**	
		0.03		*0.03*		*0.03*		*0.03*		*0.03*	
Disparity of net Single Farm Payment		**0.10**	***	**0.09**	***	**0.03**		**0.07**	**	**0.01**	
		0.03		*0.03*		*0.03*		*0.03*		*0.04*	
Disparity of net other grants and subsidies		**0.23**	***	**0.24**	***	**0.30**	***	**0.28**	***	**0.17**	***
		0.03		*0.03*		*0.03*		*0.03*		*0.03*	
Index of systematic reranking	H_R	**-17**		**-65**		**-7**		**-4**		**-13**	
		922		*1107*		*636*		*730*		*990*	
Total classical horizontal inequality		**-9269**	***	**-9916**	***	**-9056**	***	**-9743**	***	**-12694**	***
		1053		*1029*		*1201*		*1294*		*1384*	
Of which:											
Between farm type	H_B	**-2954**	***	**-4364**	***	**-3434**	***	**-3294**	***	**-5456**	***
		863		*1111*		*1171*		*996*		*1405*	
Within farm type	H_W	**-6316**	***	**-5552**	***	**-5622**	***	**-6449**	***	**-7238**	***
		668		*684*		*656*		*908*		*887*	

The classical horizontal inequalities increase substantially compared to the historic model, but this disequalizing impact is smaller than with the flat rate scenario. More specifically, the level of within-type inequality is roughly comparable between both regional model alternatives, but the between-type inequality is smaller with the split rate model (although still between 1.8 and 4.4 times higher than with the historic model).

This reflects the intermediate nature of the LFA/non-LFA split; the distinction between different types of land reduces the extent to which regional model cuts the link with the previously discussed historic coupled system that broadly served to keep all commodities comparably profitable at the margin.

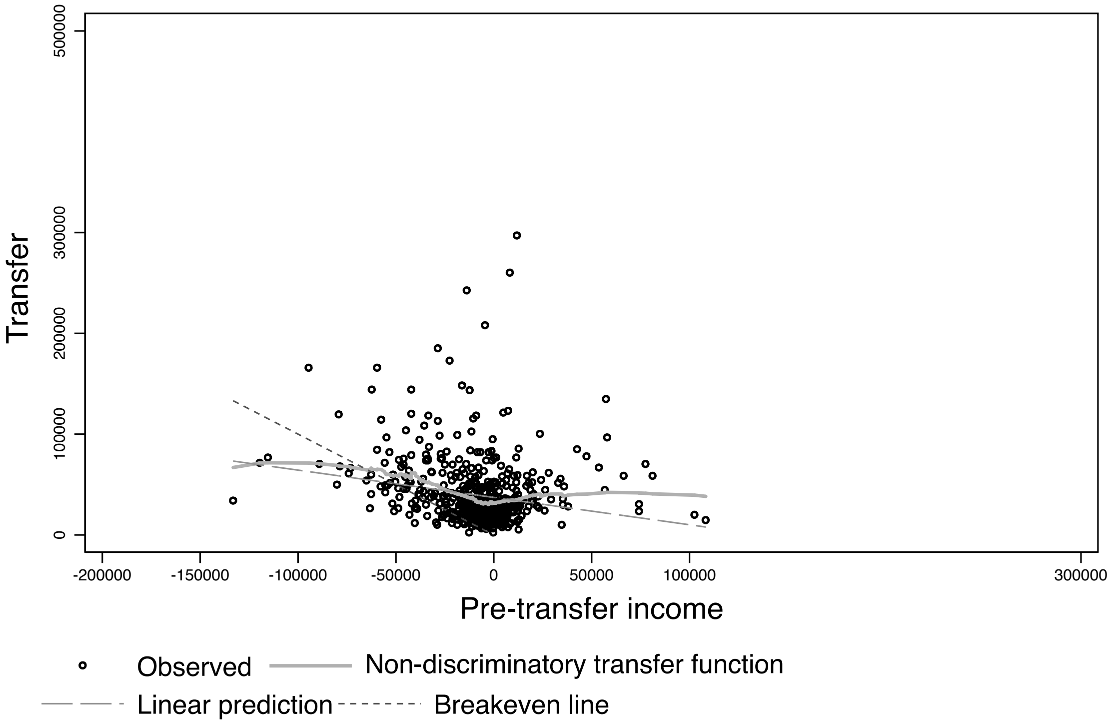
The impact of systematic reranking is even smaller than with the flat rate model and consistently statistically insignificant at 10% level.

Moving onto the graphical presentation of results in Figures 4.11 – 4.15, the slope of the non-discriminatory transfer function in the range of positive pre-transfer incomes is not flattened as much relatively to historic model as with the flat rate scenario; in fact it is roughly between the historic and flat rate slopes. This is to be expected given the intermediate nature of this model, reflecting the absence of any redistribution from wealthier non-LFA holdings to poorer LFA farms.

There is another difference between the two regional models. With flat rate across Scotland the non-discriminatory transfer function for negative pre-support incomes also flattened substantially compared to the historical model, while with the LFA/non-LFA scenario the function in that range flattens less, and in some years there is almost no difference in the slope of the line between historical model and the LFA/non-LFA alternative. This is because some of the farms with the pre-support losses are non-LFA holdings, which means they are better off with the split rate rather than the flat rate model. The positive impact of the LFA/non-LFA model on the non-LFA farms with pre-support losses helps to explain why the percentage of farms with negative post-support income would be smaller in some years than with the flat rate model, which is

Figure 4.11 Non-discriminatory transfer function and farm type specific functions, LFA/non-LFA, 2006.

Panel A



Panel B

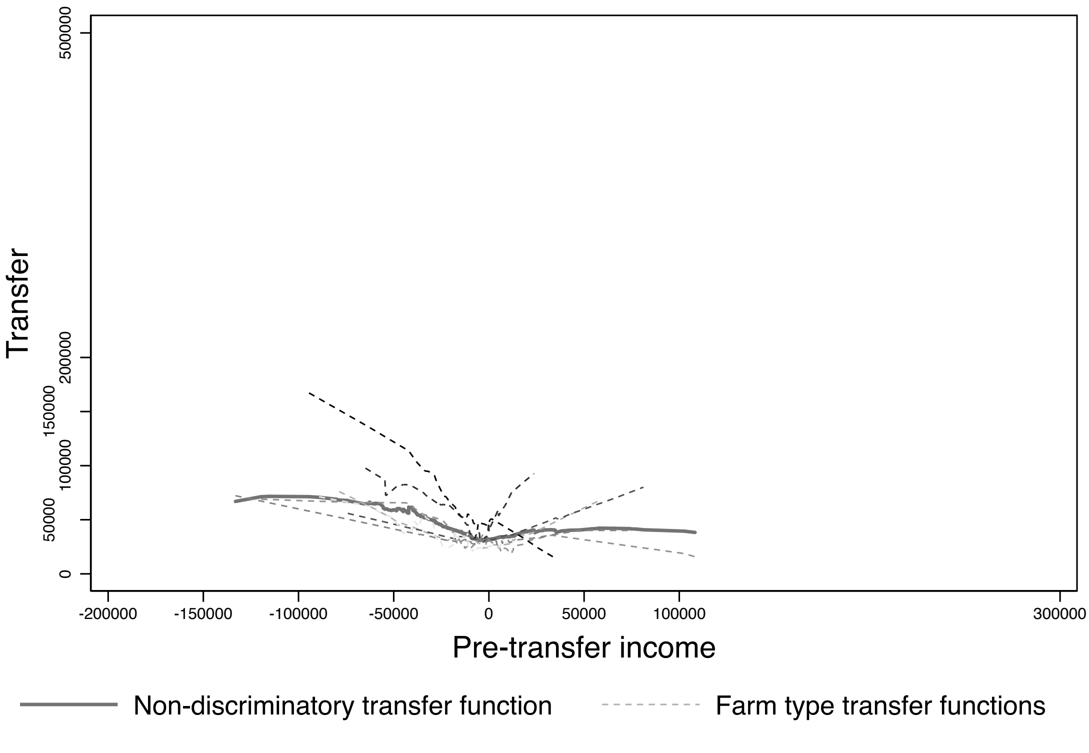
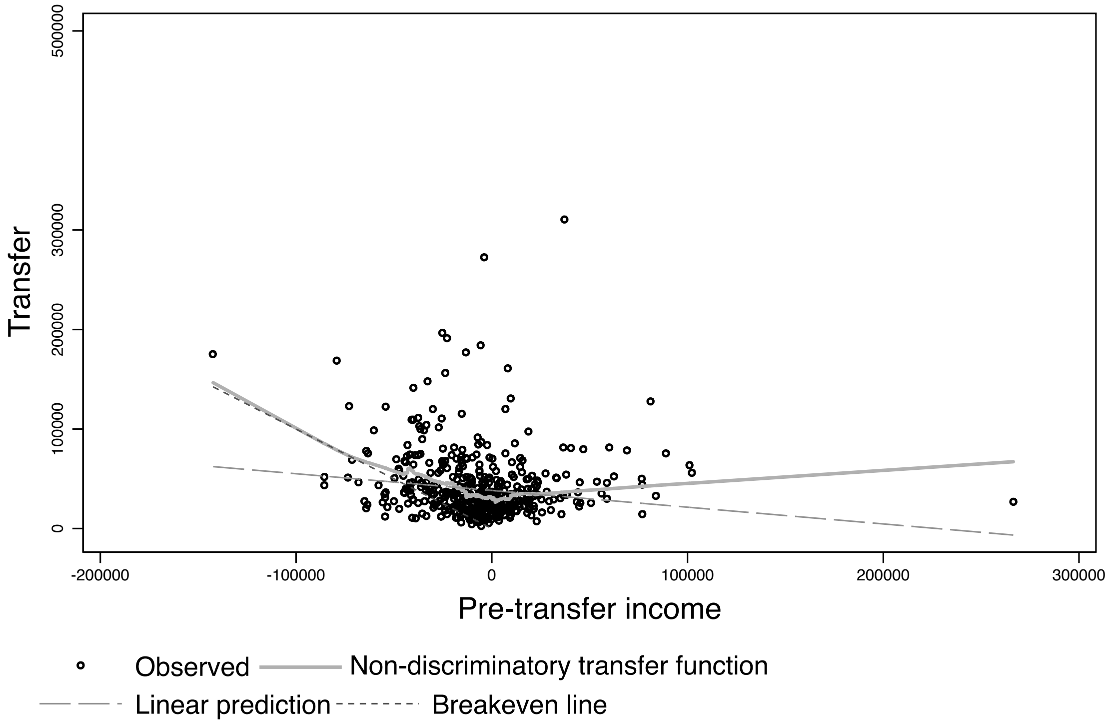


Figure 4.12 Non-discriminatory transfer function and farm type specific functions, LFA/non-LFA, 2007.

Panel A



Panel B

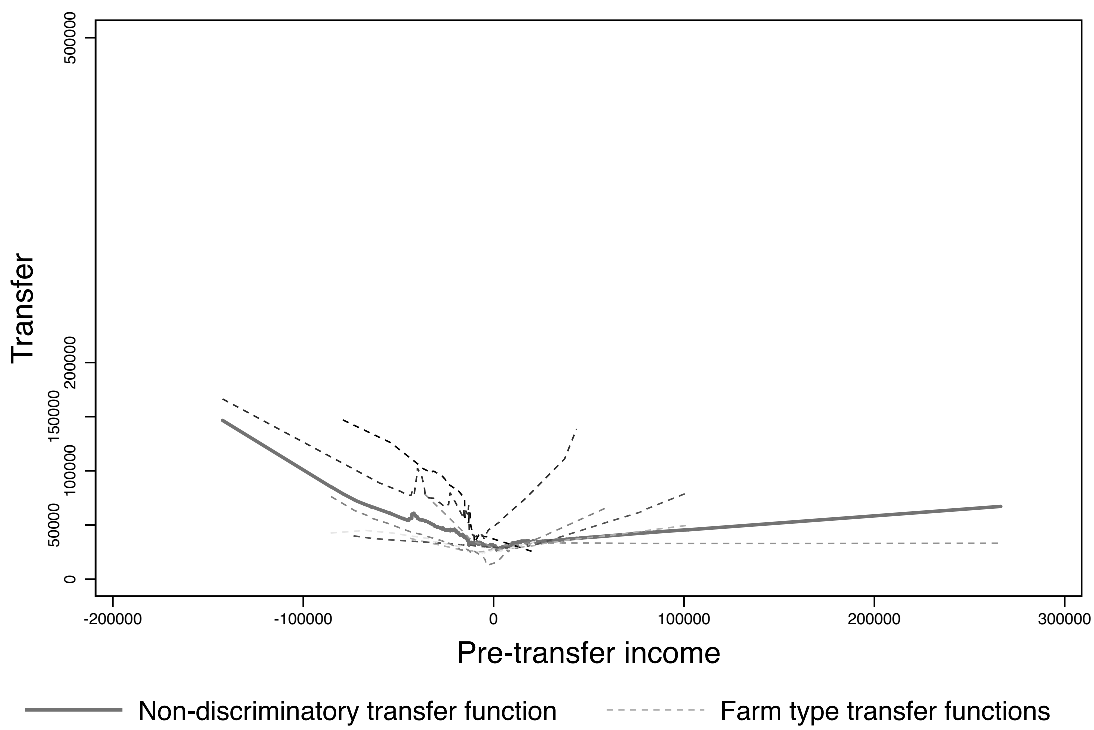
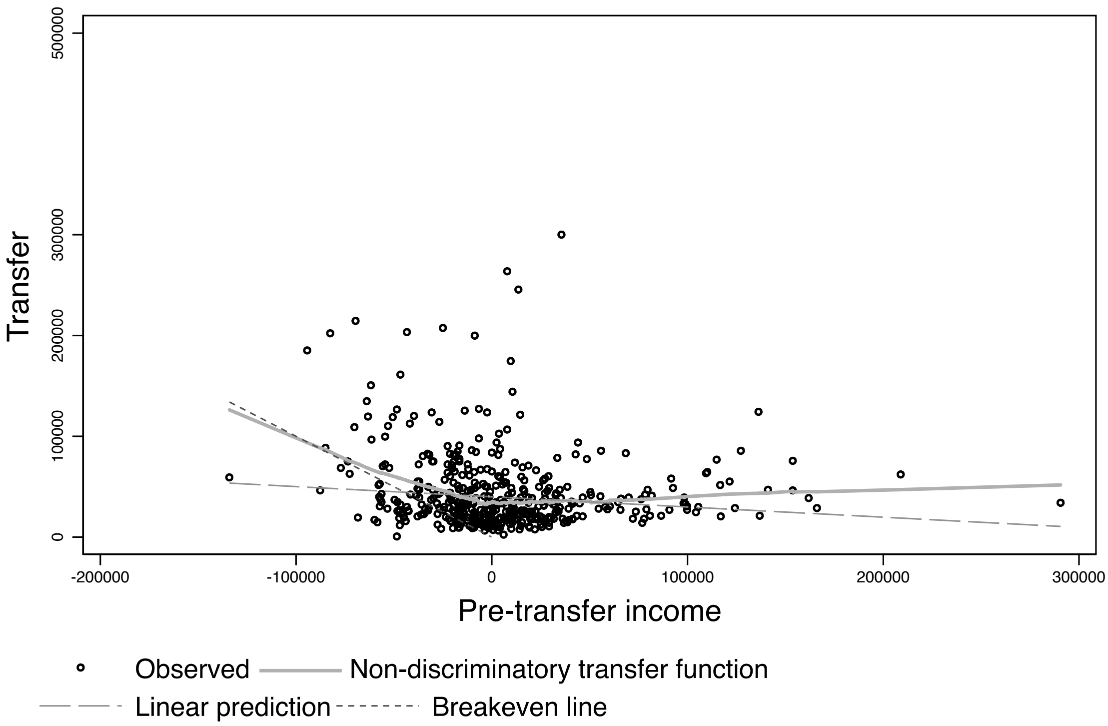


Figure 4.13 Non-discriminatory transfer function and farm type specific functions, LFA/non-LFA, 2008.

Panel A



Panel B

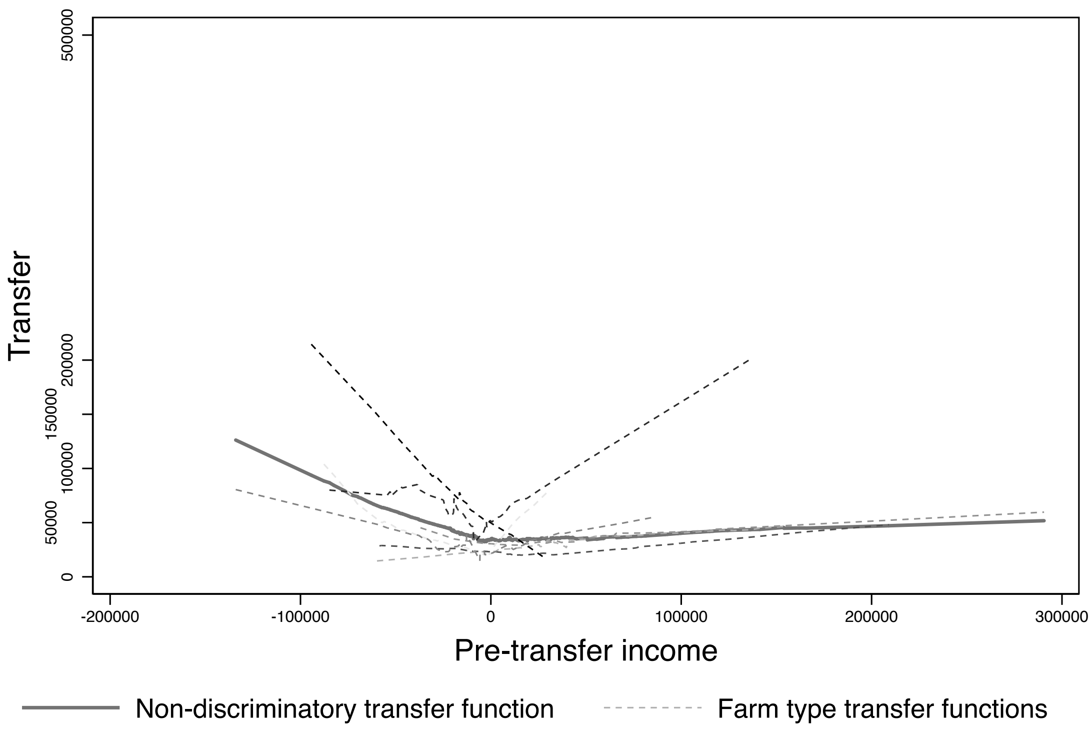
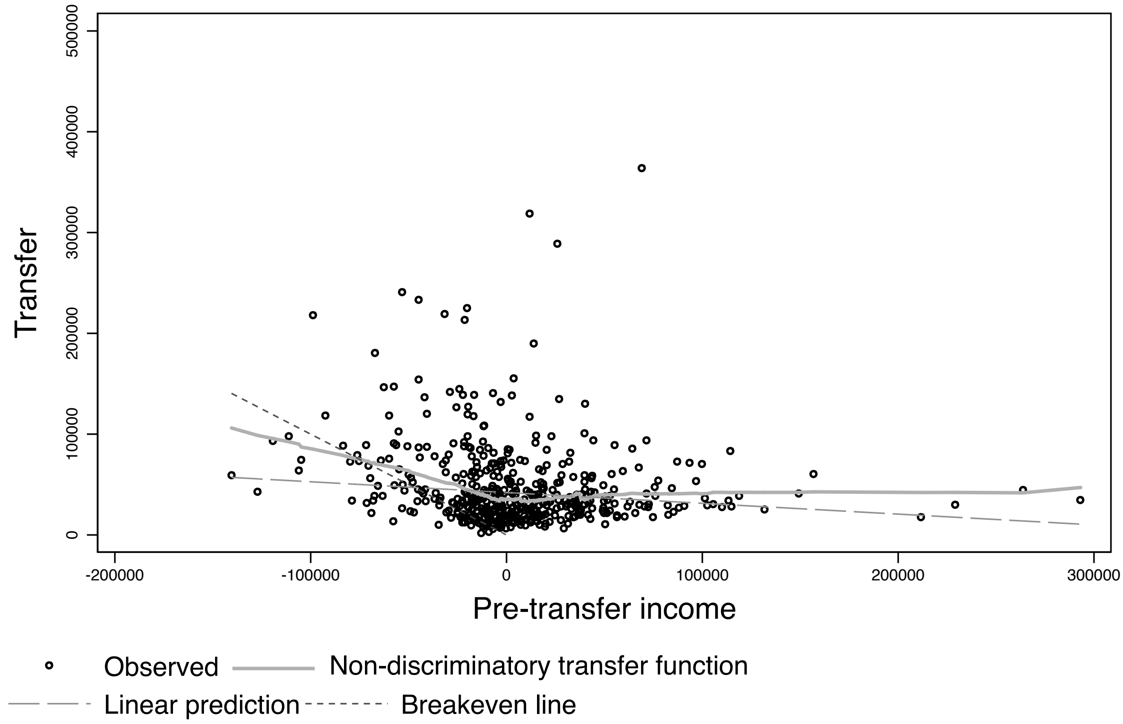


Figure 4.14 Non-discriminatory transfer function and farm type specific functions, LFA/non-LFA, 2009.

Panel A



Panel B

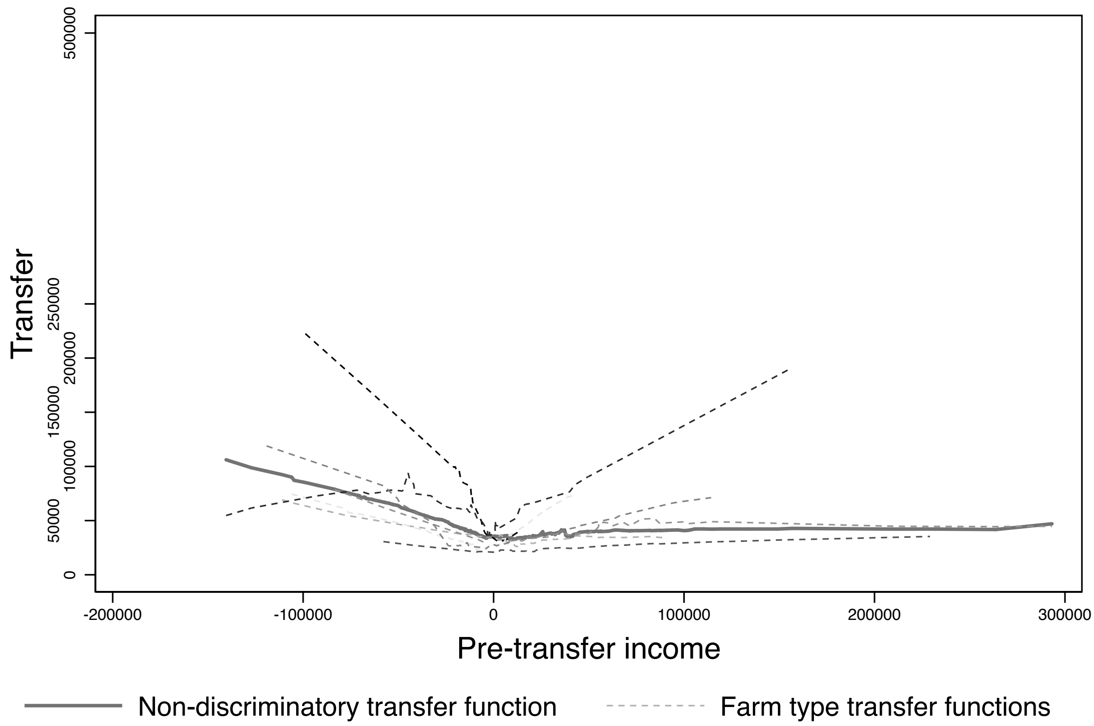
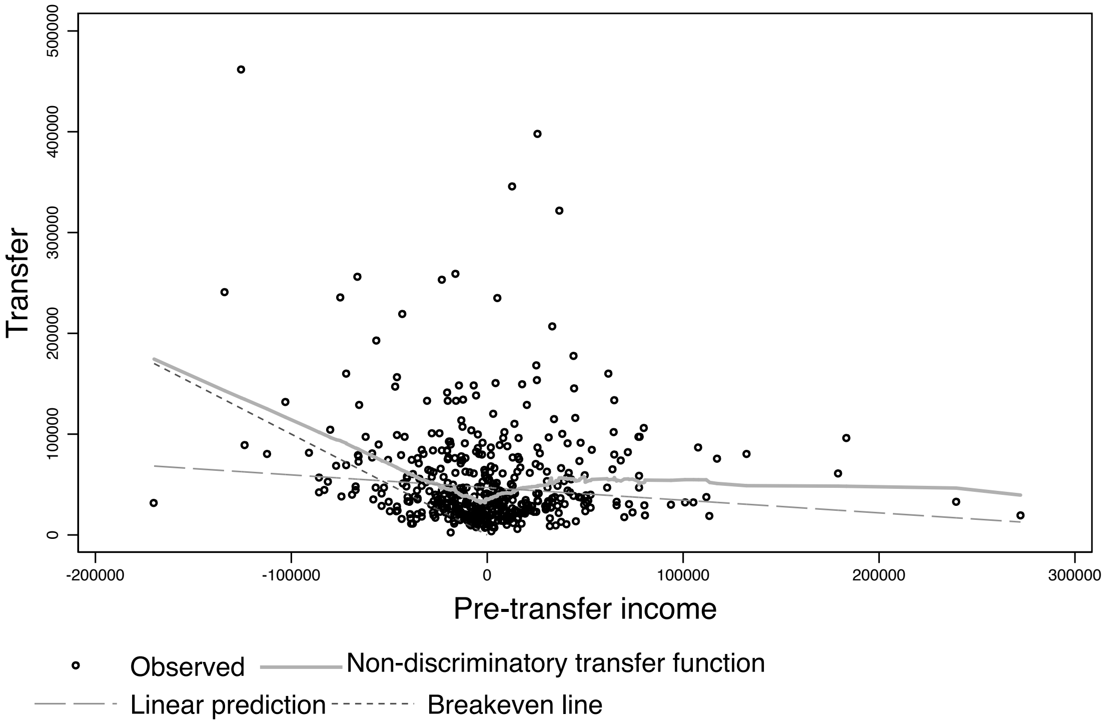
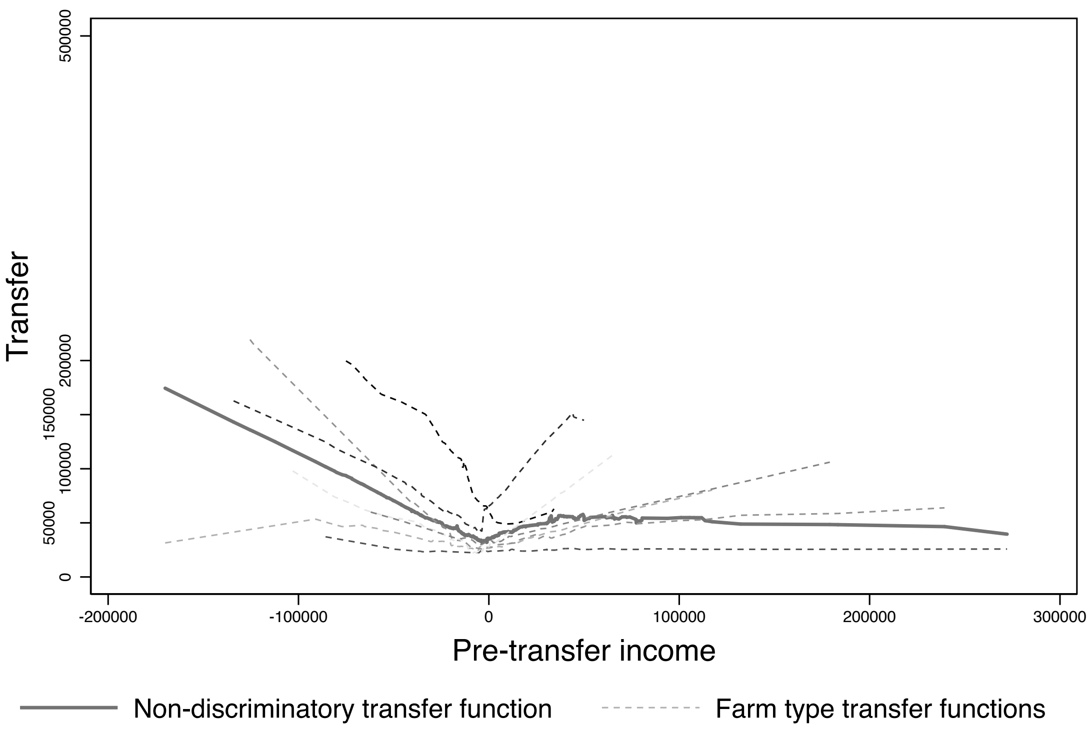


Figure 4.15 Non-discriminatory transfer function and farm type specific functions, LFA/non-LFA, 2010.

Panel A



Panel B



also reflected in a slightly smaller number of farms below the breakeven line. However, the farms with the largest pre-support losses are a heterogeneous group (in terms of farm type and LFA status) that changes between the years, and since these farms will have strong influence on the slope of the function, the impact of two rates on the transfer function slope varies between the years and no simple story can be told to explain this impact.

Summing up, switching to either version of the regional model solutions would have caused an increase in absolute income inequality, which contrasts with the popular belief that the redistribution of support between farms and regions would somehow be more equitable. From procedural point of view the regional model may be considered fairer, but the analysis shows that actually it is a more disequalizing solution. The extent of the redistribution of support and its disequalizing consequences are mitigated in the LFA/non-LFA model compared to the flat rate one. The LFA/non-LFA model would both lead to a smaller extent of discrimination between farm types and reduce the percentage of farms with post-support losses compared to the flat rate solution, as reflected in the number of farms below the breakeven line (this is true for most, but not all years). However, Dairy, Mixed and Specialist Cattle farms on LFA land would see their transfer levels diminish compared to the historic model due to averaging of entitlement values with LFA Specialist Sheep and Cattle & Sheep farms (which would still benefit relatively to historic model but less than under flat rate). These results bring up the issue of profitability of certain commodities under regional model, and in particular they support concerns about the viability of beef production and resultant calls for retention of some form of coupled support to help these enterprises (Pate, 2014).

4.4.3.4 Comparison with Allanson's results

In his study Allanson (2008) looks at the redistributive effect in the years 2001 - 2005. It is useful to compare his set of results from Tables 4.13 and 4.14 to the results from historic model in this study in order to contrast the redistributive effect of the policy with and without the SPS. It needs to be noted that Allanson's results were calculated using different assumptions on the incidence of direct payments (see section 4.4.1).

Table 4.13 Weighted summary statistics by year 2001 -2005.

	2001	*2002*	*2003*	*2004*	*2005*
Number of observations	450	386	376	444	460
Farm business size (ESU)	63	63	64	53	54
Post-transfer income (£)	28641	29523	27610	36570	36327
% of farms with post-transfer income<0	6%	8%	10%	4%	6%
Pre-transfer income (£)	304	1411	-2650	4661	-1551
% of farms with pre-transfer income<0	58%	57%	58%	52%	57%
Gross support (£)	41975	42631	46771	49711	57007
Components:					
Market price support	16712	17272	19041	20514	20529
Single Payment Scheme	20627	20226	22154	24579	29357
Other grants and subsidies	4636	5133	5575	4618	7121
Net transfer to farmers (£)	28337	28112	30260	31909	37878
Components:					
Market price support	9497	9710	10589	11686	11629
Single Payment Scheme	16254	15522	16766	17879	22811
Other grants and subsidies	2586	2880	2905	2344	3437
Net support as % of post-support income	127%	115%	89%	88%	96%

Source: Source: Allanson, 2008.

The redistributive effect is negative for all years for both study periods. The average for 2001 - 2005 is -3091 and for 2006 - 2010 is -3336, implying that the reform slightly increased the disequalizing impact of the policy.

The channel through which the disequalizing impact worked can be seen by inspecting the subcomponents of the effect. The vertical component is on average higher in the post-reform period, with the mean value of 3278 compared to 2574 in the pre-reform period. However, a closer inspection reveals that the higher progressivity is entirely due to an increase in the mean non-discriminatory transfer from 31691 to 41479[30], while the average disparity index in both periods is 0.08.

Table 4.14 Redistributive effect decomposition 2001 – 2005.

		2001	2002	2003	2004	2005
Absolute Gini index of post-transfer income	$\boxed{A_Y}$	**15754** ***	**16350** ***	**14299** ***	**16532** ***	**17788** ***
		1214	*853*	*793*	*915*	*897*
Absolute Gini index of farm type specific reference income	$\boxed{A_W}$	**12324**	**12788** ***	**10197** ***	**12868** ***	**12266** ***
		13411	*981*	*973*	*1128*	*1038*
Absolute Gini index of non-discriminatory reference income	$\boxed{A_B}$	**10550** ***	**12008** ***	**7701** ***	**11257** ***	**10550** ***
		1441	*1095*	*1206*	*1282*	*1245*
Absolute concentration index of non-discriminatory reference income (by start income)	$\boxed{\bar{y}_B C_B}$	**10217** ***	**12005** ***	**7503** ***	**12005** ***	**10217** ***
		1500	1300	1449	1421	1505
Absolute Gini index of pre-transfer income	$\boxed{A_X}$	**14188** ***	**13212** ***	**10664** ***	**13730** ***	**13473** ***
		1030	*818*	*649*	*759*	*796*
Index of redistributive effect	$\boxed{R}$	**-1566** **	**-3137** ***	**-3635** ***	**-2802** ***	**-4315** ***
		659	*703*	*795*	*578*	*857*
Index of vertical redistribution	$\boxed{V}$	**2748** ***	**1972** **	**3161** **	**1725**	**3256** **
		898	*960*	*1511*	*1110*	*1366*
Disparity of net transfers	$\boxed{D}$	**0.10** ***	**0.07** **	**0.10** ***	**0.05** *	**0.09** ***
		0.03	*0.03*	*0.04*	*0.03*	*0.03*
Mean non-discriminatory transfers	$\boxed{\bar{t}_B}$	**28325** ***	**28949** ***	**30987** ***	**32638** ***	**37557** ***
		2257	*2380*	*2831*	*2748*	*3147*
Index of systematic reranking	$\boxed{H_R}$	**-156**	**-17**	**-198**	**-3**	**-334**
		281	*538*	*574*	*322*	*659*
Total classical horizontal inequality		**-4159** ***	**-5093** ***	**-6598** ***	**-4524** ***	**-7238** ***
		600	*744*	*1034*	*728*	*894*
Of which:						
Between farm type	$\boxed{H_B}$	**-728** *	**-1513** ***	**-2496** ***	**-860** *	**-1716** ***
		409	*487*	*664*	*454*	*646*
Within farm type	$\boxed{H_W}$	**-3431** ***	**-3561** ***	**-4101** ***	**-3664** ***	**-5522** ***
		394	*496*	*647*	*478*	*585*

Source: Source: Allanson, 2008.

The increase in mean value of transfer needs to be taken into context also when analysing the classical horizontal inequalities component; while both between and within type inequality indices are slightly higher for the post-2005 period, this result should be considered in terms of a ratio to the mean net transfer value. When we look at the ratio for both components, it remains pretty stable across the years. As such, the results indicate that the increase in absolute inequality is due to the increase in average value of transfers, but relative to the value of support, the disequalizing classical

[30] Where part of this will be due to differences in the assumptions about transfer efficiencies, and part due to the change in average gross support levels.

horizontal inequalities remain roughly constant. In other words, the distribution of support does increase absolute inequality more in the years with SFP, but not due of the design of the policy. Instead, more money is redistributed through the policy post-2005 and therefore there is more scope for it to increase the income differentials. While the gross value of support has increased between the two periods, the transfer efficiency is slightly different due to the assumptions made, and therefore the increase in net transfer is even larger. For Allanson's results without SFP, the transfer efficiency oscillated between 64% to 68%, whereas with the SFP in place it ranges between 68% and 77% (see Table 4.11 and Table 4.1). As such, the results are not directly comparable.

However, correcting for the higher value of transfers, the comparison shows that not much has changed in redistributive performance between the years prior to the introduction of the SFP and post its introduction. The Scottish Government's adopted the historic model "as a measure that would limit the redistribution that would occur with a move away from payments that were linked to production" (Pack, 2010b, p. 47). In this context, the choice of the historic model appears to have met the government's goal of not to create winners and losers with the introduction of the SFP.

4.5 Conclusions

The purpose of this chapter was to analyse the redistributive effect of agricultural policy in Scotland with the SPS implemented using the historic model in the production years 2005/06 to 2009/10. In addition, the redistributive effect under current arrangement was compared to the effect of two hypothetical scenarios where the scheme is put in place using alternative versions of the regional model of distribution.

The focus of this exercise on the equity aspect of agricultural policy can be criticized considering the policy has many objectives other than income support, such as environmental protection, rural development or sustainability. Nevertheless, the equitable distribution of farming income is a very important aspect of the policy that has been recognized as problematic by officials at national (Pack, 2010a) and international levels (OECD, 2003).

The methodology, following Allanson (2008), is based on the measurement of redistributive effect as the change in absolute income inequality, which can be interpreted as the monetary value per farm of the inequality change resulting from the provision of support. The measure is then broken down into vertical and horizontal equity components. It provides an explicit picture of the redistributive performance of a support scheme, and is informative for the targeting aspect of policy. Specifically, the methodology addresses the problem of horizontal inequalities in provision of support which is largely neglected by pre-existing literature.

The analysis of the current arrangement highlights the chronic dependence of agriculture on financial support. Over half of the Scottish farms would be experiencing negative incomes in the absence of support, and between 5% and 8%, depending on the year, suffer from negative incomes even after the support is provided.

The provision of support reduced income disparities between farm types on average, since the dispersion of post-transfer incomes between types of farms was actually smaller than that of pre-transfer incomes. However, the distribution of support leads to an increase in absolute income inequality among farms.

The transfers are progressive in absolute terms, which means that poorer farmers (that is farms at the bottom of pre-support income distribution) got more than their equal share of non-discriminatory transfers, in spite of the common belief that CAP provides most support to big and affluent farms (European Commission, 2002). This contradiction can be easily explained since the common belief is based on the assumption that agriculture would have been profitable even without the provision of support (Allanson, 2008). In reality however, as the results indicate, some farms would not be able to stay in business without financial aid. Many farms that received high payments in the reference period, and accordingly large transfers under the SFP, are also some of the farms that would go out of business without the transfers, since they would generate huge losses on their level of agricultural activities. This can be seen in the shape of the non-discriminatory reference function which is downward sloping for the negative pre-transfer incomes range, indicating that the progressivity of support is largely driven by these farms receiving more than their equal share of support.

Despite the fact that actual money transfers are progressive in absolute terms, the absolute inequality increases with support as an effect of large horizontal inequalities. The results show that these inequalities resulted mainly from unequal treatment of pre-transfer income equals rather than from systematic reranking of farms in the distribution of support. Furthermore, the main driver of the classical horizontal inequalities was the weakness of the relationship between pre-transfer incomes and transfers within a specific farm type, rather than discrimination between farm types producing different commodities. This weakness of the relationship between pre-support incomes and transfer levels implies the inability of support to target farms in need accurately through the existing support system. More specifically, policies designed to focus support on farms with low income by limiting the size of payments received by large farms under current arrangement (e.g. modulation) would be largely ineffective (Allanson, 2008) given the wide variation in transfers received by farms with similar pre-transfer incomes.

After comparing the results of this analysis to the results of Allanson (2008) who looked at the redistributive effect in years 2001 – 2005, it can be concluded that the SFP introduction under the historic model did not significantly change the redistributive performance of support. As such, the historic model met its objective of minimising the redistribution of support in Scotland compared to distribution under the coupled direct payments.

Since the historic model will become obsolete with the new CAP reform, which aims to introduce area-based entitlement rates across regions and countries, the results from the regional model simulations are of particular interest. The analysis of alternative scenarios under the regional model looked at support distributions based on two implementation approaches: Scotland as one region with flat rate of entitlements or Scotland with two rates divided according to LFA and non-LFA areas. The regional model is widely believed to be more equitable, since the distribution of support does not depend, or depends to a lesser degree, on the level of support in the reference period and therefore it allows for more support going to farmers who were less supported in the reference period. On the other hand, such redistribution would also create losers in the sense that farms which previously received higher levels of support would see it being reduced; this existence of losers makes this model problematic in terms of political cost.

The results from the flat rate scenario indicate an increase in the progressivity index, which is higher than with the historic model for all years. However, further analysis shows that the higher progressivity with the flat rate is largely due to lower regressivity of support for farms which break even in the absence of subsidies, while the impact on farms which are loss-generating without support would be mixed. More specifically, the flat rate leads to a redistribution of support towards Specialist Sheep and Cattle & Sheep farms, but this happens at a cost to all other farm types. Some of the farms with negative pre-support income see their support levels reduced with the flat rate, which is reflected in an increase of the number of farms that do not break even with the support in place. The redistribution of support between farm types leads to a large increase in between-type classical horizontal inequality compared to the historic model; because of this the flat rate model is more disequalizing than the historic one.

The increases in progressivity of support and the extent of between-type inequality were mitigated under the LFA/non-LFA scenario, which reflects the reduced degree of redistribution and intermediate nature of the model. This scenario would allow the non-LFA holdings to enjoy transfer levels comparable to the historic model ones. However, while Sheep or Cattle & Sheep farms on LFA land still benefit from this scenario relatively to the historic model, other farm types on LFA land would be largely disadvantaged by the two rates solution because averaging their entitlement values with the low level of per hectare support on Sheep and Cattle and Sheep farms (without the non-LFA farms bringing the average up) would significantly reduce their support levels. In terms of policy implications, the more progressive distribution of income might be desired by policy makers, but in the context of political economy, this can cause some opposition from farmers who would receive less benefit with such an arrangement. The historic model was chosen in Scotland in the first place to avoid big changes in the distribution of support under the SPS. As such, the Scottish Government might be interested in adopting a variation of the regional model that would change the distribution as little as possible. Intuitively it can be expected that the more thorough the division into different land capability levels, the less redistribution there would be. Current considerations of the Scottish Government concerning the introduction of the area-based payments suggest it will in fact opt for 2 or 3 regions in Scotland, instead of a flat national rate (see section 2.2.5).

The disequalizing impact of classical horizontal inequalities under the regional model alternatives means that in fact it increases absolute income differentials more than the regional model. Therefore in spite of appearing as a fairer solution form procedural point of view, the regional model is actually more inequitable. In particular, the between-type discrimination increases sharply with both version of the regional model (although two rates of entitlements mitigate this impact). The reason behind this is the fact that the previous system of support has been implicitly balanced in a way that ensured no commodity was more profitable at the margin than others and therefore prevented farmers from switching production and oversupplying this commodity at the cost of others. This balance has to a certain extent been maintained by the historic model of distribution through the link with the level of payments in the 2000-2002 reference period. Cutting this link under the regional model caused the discrimination between commodities to increase sharply, which would appear to a lesser degree under the LFA/non-LFA model than with a single flat rate across Scotland.

If the policy makers are concerned that profitability of some commodities might be at risk under the regional model, they can consider introduction of coupled payments for these products. In fact, the new CAP allows for a share of the national funding to be directed towards coupled payments at the discretion of the national governments (see section 2.2.5), and the results of this analysis suggest this could be a useful option for Scotland. In particular, if the LFA/non-LFA model was chosen, Cattle, Mixed and Dairy farms on LFA land would see a sharp drop in profitability; this supports the existing concerns over profitability of Cattle farming under the regional model.

5 Income determinants model

5.1 Introduction

The purpose of this chapter is to develop a model which captures the determinants of individual agricultural income changes; the estimates from this model are then going to be used in the subsequent chapter for a regression-based decomposition of inequality. In this context, a dynamic model is specified since the results of cross-sectional regression will be biased if the underlying income function is dynamic rather than static. The coefficients from the model will serve to decompose an index of vertical mobility, and the long-run parameters of the model will serve to quantify and then decompose the equilibrium, or chronic, inequality in the agricultural incomes.

If one assumes a stable dynamic income function over time, then a first-order autoregressive distributed lag-model can be specified, and easily converted into an Error Correction Model. A model like this shows that present income is determined not only by current levels of income determinants but all past levels as well. Analytically, such a model is attractive as it distinguishes between long-run equilibrium relationship and the short-run dynamics.

Agricultural income will be modelled as a function of the economic size of farms, which captures their income generating capacity, with a distinction between cropping and livestock activity. The model will also control for idiosyncratic and time fixed effects.

The chapter starts with a theoretical description of the model in section 5.2, followed by a section on econometric issues and possible estimation methodologies. Section 5.4 describes the data and variables used in the empirical model specification, as well as the model results, followed by estimates from different methods which serve as a robustness check. The chapter is closed with conclusions in section 5.5.

5.2 Theoretical model description

The model's aim is to capture the determinants of individual income changes. Assuming a stable dynamic income function over time, a first-order autoregressive distributed lag model (ADLM) can be specified, with lagged and contemporaneous responses to changes in income determinants (Davidson *et al*., 1987, Alogsokoufis and Smith, 1991):

$$y_{t+1} = \alpha_0 + \sum_{k=1}^{K} \delta_k x_{k,t+1} + \sum_{k=1}^{K} \alpha_k x_{kt} + (1-\lambda) y_t + \upsilon_{t+1} \tag{5.1}$$

t=1, … *T-1*

where the composite error consists of both individual farm fixed effect and idiosyncratic error terms, $\upsilon_{i,t+1} = \alpha_i + \varepsilon_{i,t+1}$. The model implies that present income is determined not only by contemporaneous levels of income determinants but all the past levels as well.

It can alternatively be expressed as an Error Correction Model:

$$\begin{aligned} \Delta y_{t+1} &= \left(y_{t+1} - y_t\right) = \sum_{k=1}^{K} \delta_k \left(x_{k,t+1} - x_{kt}\right) + \lambda\left(\left(\beta_0 + \sum_{k=1}^{K} \beta_k x_{kt}\right) - y_t\right) + \upsilon_{t+1} \\ &= \sum_{k=1}^{K} \delta_k \Delta x_{t+1}^{k} + \lambda\left(y_t^* - y_t\right) + \upsilon_{t+1}\ ; \end{aligned} \tag{5.2}$$

where $\beta_0 = \alpha_0 / \lambda$ and $\beta_k = \left(\alpha_k + \delta_k\right) / \lambda$ can be interpreted as parameters of the long-run income relationship:

$$y_t^* = \beta_0 + \sum_{k=1}^{K} \beta_k x_{kt} \tag{5.3}$$

with $\left(y_t^* - y_t\right)$ corresponding to the *equilibrium error* in the current period and $\lambda\left(0 \le \lambda \le 1\right)$ representing the rate of adjustment towards equilibrium. If $\lambda = 1$, and all α_k's (k=1,…K) are zero, there is full adjustment and the equation collapses to a static model with $y_t = y_t^* + \upsilon_t$ in all periods. This means that the estimates of the model will indicate whether the dynamic framework is suitable for it.

Error Correction Models can be used with stationary or co-integrated non-stationary data where exogenous factors have different short-run and long-run effects or if there is a persistence of shocks (Keele and De Boef, 2004). The ECM formulation shows that the change in income over the following period is determined by the effects of current changes in income determinants, any deviation from the equilibrium income in the current period, and the size of the idiosyncratic income shock in the next period. This representation is very attractive from an analytical point of view because of the clear distinction between long-run equilibrium relationships and the short-run dynamics. Specifically, this allows to look at short-run impact of policy interventions which influence income determinants, as well as the persistent, or chronic income situation.

The theoretical justification behind the specification of a model where current income levels depend on the past income levels is the assumption that farmer's ability to grow is sensitive to cash flow, and therefore it will be constrained by his/her past income levels if the investments are made from retained earnings (Benjamin and Phimister, 2002). This will be the case in the presence of credit constraints, which concern farmers, particularly with low incomes (European Parliament, 2014).

5.3 Estimation issues

A crucial issue with estimating the dynamic model of agricultural income is choosing the right estimation method. What follows is a description of some possible estimators for this kind of model, what econometric issues they address and what shortcomings they might have.

Bond (2002) provides a good overview of some estimation methods for microeconomic dynamic panels, with observations on many individuals across short period of time and explanatory variables that are not strictly exogenous. To begin with, OLS is not an appropriate approach, since by definition the lagged dependant variable is correlated with the composite error because of individual effects – a correlation that does not disappear as the sample gets larger. Based on omitted variables results, this makes the OLS estimator biased upwards (Bond, *Ibid.*).

The fixed effect (FE) estimator is not an optimal method either. Specifically, with the FE estimator, the original observations are expressed as deviations from means of the dependant and explanatory variables, idiosyncratic error ε_{it} and fixed effects α_i. Since the mean of α_i is α_i, individual effects are eliminated and OLS is then used to estimate the model. Unfortunately this creates a correlation between the transformed error term and transformed lagged dependant variable which is significant for panels where the number of time periods is not large. Since the transformed lagged dependant variable is given as $y_{i,t-1} - \frac{1}{T-1}(y_{i1} + ... + y_{it} + ... + y_{i,T-1})$ and the transformed error terms by $\varepsilon_{it} - \frac{1}{T-1}(\varepsilon_{i2} + ... + \varepsilon_{i,t-1} + ... + \varepsilon_{iT})$, the term $\frac{-y_{it}}{T-1}$ is correlated with ε_{it} and the term

$\frac{-\varepsilon_{i,t-1}}{T-1}$ is correlated with $y_{i,t-1}$. These are leading negative correlations, which dominate positive correlations between other components, therefore the correlation between the transformed error term and transformed lagged dependant variable is negative. Because these correlations do not vanish even as the number of observations increases, the FE estimator is inconsistent (Nickell, 1981). According to standard results on omitted variable bias, the FE estimator should be downward biased in large samples (Bond, 2002).

The fact that OLS and FE estimators are biased in opposite directions is in fact extremely useful, as they will indicate upper and lower bounds for any unbiased estimator.

There have been Maximum Likelihood estimators developed for this sort of model, however dynamic models are characterized by the fact that distribution of y_{it} for t=2,3,...,T depends rather significantly on our assumptions about how the initial conditions y_{i1} are distributed. There are a variety of possibilities; the process could be stochastic or non-stochastic, y_{i1} could be correlated or uncorrelated with α_i, etc. Crucially, different assumptions about the nature of initial conditions will lead to different specifications of the likelihood function, which means that the Maximum Likelihood estimator will be inconsistent if the initial conditions process is not specified correctly.

In this context, Instrumental Variables estimators, which require weaker assumptions about the initials conditions, have proved popular. Anderson and Hsiao (1981, 1982) proposed the first basic first-differenced Two Stage Least Square (2SLS) estimator for an autoregressive distributed lag panel data model:

$$\Delta y_{i,t+1} = \eta \Delta y_{it} + \chi \Delta x_{i,t+1} + \upsilon \Delta x_{it} + \Delta \varepsilon_{i,t+1}; |\eta| < 1; i = 1,2,...N; t = 2,3,...,T \qquad (5.4)$$

The first-differencing serves to eliminate the individual effects α_i from the model, but unlike FE transformation, it does not introduce all realisation of the disturbances into the error term of the transformed equation. Nevertheless, the dependence of Δy_{it} on ε_{it} means that the OLS estimator of η in (5.4) is inconsistent, with a downward bias that is usually bigger than that in FE estimation. This problem can be fixed by using 2SLS with instrumental variables that are correlated to Δy_{it} and uncorrelated with $\Delta \varepsilon_{i,t+1}$. The only necessary assumption about the initial conditions here is that they are uncorrelated with the disturbances, $corr(y_{i1}, \varepsilon_{it})=0$ for $t=2,3,...,T$, which means the initial conditions are said to be predetermined. Predetermined initial conditions, together with the previous assumption that the disturbances are serially uncorrelated, mean that $y_{i,t-1}$ is uncorrelated with $\Delta \varepsilon_{i,t+1}$ and can therefore be a valid instrument. Such a 2SLS estimator is consistent in fixed T and large N panels and can identify η as long as observations for at least three periods are available.

With more than 3 time series observations, additional instruments are available. For example, only y_{i1} can be used with t=3, but with t=4, both y_{i1} and y_{i2} are available as instruments, and the vector $(y_{i1}, y_{i2},...,y_{i,T-2})$ for period $t=T$. With T>3 the model is overidentified, which, together with the fact that the first-differenced error term $\Delta \varepsilon_{i,t+1}$ has a moving average form of serial correlation (if the assumption about no serial correlation in ε_{it} is correct), means that 2SLS is not asymptotically efficient, even if all the available instruments for each equation are used and the disturbances are homoskedastic (Bond, 2002). A solution to this problem is developed by Hansen (1982) within a Generalized Method of Moments (GMM) framework, which serves to provide a consistent estimator in this situation. First-differenced GMM estimators for the type of model in question here were developed by Holtz-Eakin, Newey and Rosen (1988) and Arellano and Bond (AB) (1991) and they are known as difference GMM. An important assumption is that there is no serial correlation in the error terms. These estimators use the moment conditions between the differenced error term and further lags of the dependent variable; $E(y_{i,t-n}, \Delta\varepsilon_{i,t+1}) = 0$ for $t=T$ and $n=3,4,....T-2$. Furthermore, if covariates are strictly exogenous, meaning that ε_{it} cannot affect x_{is} for any s or t, then the first–differences of strictly exogenous covariates are also used as instruments; $E(x_{is}\varepsilon_{it}) = 0$ for all s and t. Lastly, these estimators allow for predetermined regressors, meaning that ε_{it} may affect x_{is} for $s>t$. In that case, the valid moment conditions are $E(x_{is}\varepsilon_{it}) = 0$ for all $s \leq t$ but $E(x_{is}\varepsilon_{it}) \neq 0$ for $s>t$.

The asymptotically efficient GMM estimator which uses this set of moment conditions is obtained by minimising the following criterion

$$J_N = \left(\frac{1}{N}\sum_{i=1}^{N}\Delta\varepsilon_i' Z_i\right) W_N \left(\frac{1}{N}\sum_{i=1}^{N} Z_i' \Delta\varepsilon_i\right) \tag{5.5}$$

where Z_i is the instrument matrix, and the matrix of weights is of the form:

$$W_N \left[\frac{1}{N}\sum_{i=1}^{N}(Z_i' \hat{\Delta\varepsilon_i} \hat{\Delta\varepsilon_i}' Z_i)\right]^{-1} \tag{5.6}$$

with $\hat{\Delta\varepsilon_i}$ representing consistent estimates of the first-differenced residuals based on a preliminary consistent estimator. This procedure is known as a two-step GMM. However, if ε_{it} are homoskedastic, the structure of the first-differenced model means that an asymptotically equivalent GMM estimator can be obtained in a one-step procedure, where the weight matrix is of the form:

$$W_N\left[\frac{1}{N}\sum_{i=1}^{N}(Z_i^{'}HZ_i)\right]^{-1} \tag{5.7}$$

with H being a (T-2) square matrix with -1's on the first off-diagonals, 2's on the main diagonal and 0's elsewhere. W_N does not depend on any preliminary estimates.

Most applied work using GMM estimators works with the one-step estimator as simulation studies have shown that the efficiency gains from two-step estimators are modest, and also the dependency of the two-step estimator on estimated parameters makes the asymptotic distributions approximations less reliable, with simulation studies showing that the asymptotic standard errors are often too small (Bond, 2002).

With T>3, when the model is overidentified, the validity of assumptions used to get the moment conditions can be tested using the Sargan test of overidentifying restrictions (Sargan, 1958, 1988; Hansen, 1982). Under the null hypothesis of valid overidentifying restrictions, NJ_N has an asymptotic $\chi 2$ distribution. The key overidentifying assumption is that there is no serial correlation in ε_{it}, which can be tested using a test of no second-order autocorrelation in first-differenced residuals (Arellano and Bond, 1991).

The difference GMM estimator forms moment conditions using lagged-levels of the dependent variable and the predetermined or strictly exogenous variables with first-differenced errors. However Blundell and Bond (1998) found that if the autoregressive process is too persistent, then the lagged-levels make for weak instruments and, accordingly proposed to use additional moment conditions between the lagged differences of the dependant variable and the levels of the disturbances, $E(\Delta y_{i,t-n}, \varepsilon_{it}) = 0$. These moment conditions are based on the assumption that the individual effect is uncorrelated with the first difference of the dependant variable, $E(\alpha_i, \Delta y_{it}) = 0$. Blundell and Bond (BB) method is called a system GMM estimator since it uses a combination of equations in first-differences with equations in levels to exploit the full set of instruments.

Instead of concentrating on getting valid instruments to remove the correlation between the transformed lagged dependant variable and the transformed error term, Kiviet (1995) approaches the problem by trying to compute a specific data-dependent correction of the bias in the fixed effect estimator. Such a bias-corrected Least Square Dummy Variable (LSDVC) estimator eliminates the small sample bias of the FE estimator. While Kiviet fixed the problem for balanced panels, Bruno (2005) developed a method suitable for unbalanced ones. The bias-corrected fixed-effects estimator uses a numerical procedure to estimate this bias and uses it to compute the bias-corrected coefficient estimates (Wintoki *et al*., 2012). The estimator requires a consistent initial estimator to obtain a coefficient of starting values in order to initialize the bias correction (the user can specify either AB or BB as options). One potentially big disadvantage of this method is that it requires the regressors to be strictly exogenous (Flannery and Hankins, 2013). However, Flannery and Hankins (*Ibid.*) performed Monte Carlo simulations with endogenous variables for the LSDVC estimator and concluded from their results that the estimator produces reasonable estimates as long as the level of endogeneity is not too high.

Since OLS is not an appropriate method due to the correlation between the regressors and fixed effects, yet another approach to estimating the model is to explicitly model the fixed effects, and then proceed with OLS. Following Mundlak (1978) and Chamberlain (1980)[31], one can model the dependence between x_{it} and α_i by assuming that α_i is a function of the means of all time-varying covariates:

$$\alpha_i = a_0 + a_1{}'\overline{x}_i^k + \gamma_i \tag{5.8}$$

where $\gamma_i \sim IN(0, \sigma_\Upsilon^2)$ and independent of x^k_{it} and ε_{it}. This formula serves to explicitly model the fixed effects using the data, where a_0 is an intercept and $\overline{x}_i^k$ is a vector of sample means across time that is composed of all the time-varying covariates for individual i. However, if α_i is correlated with y_{i1}, one needs to control for the initial conditions problem. In this case, initial conditions need to be explicitly modelled rather than assumed to be exogenously given.

Following Heckman (1981c), one can specify a reduced form equation for it, $y_{i1}^* = \lambda' z_i + \varphi_i$ with $\mathrm{var}(\varphi_i) = \sigma_\varphi^2$ and $cor(\gamma_i, \varphi_i) = \rho$ and z_i being a vector of strictly exogenous instruments, including variables relevant in the first period, pre-sample information about the dependable variable and vector of means $\overline{x}_i$. To account for the possibility of non-zero ρ, the following relation is specified $\varphi_i = \theta\gamma_i = \varepsilon_{i1}$, where γ_i and ε_{i1} are orthogonal, $\mathrm{var}(\varepsilon_{i1}) = \sigma_\varphi^2(1-\rho^2)$ and $\theta = \rho\sigma_\varphi / \sigma_\gamma$. This means that the final version of the model looks like:

$$y_{it}^* = x_{it}{}'\beta + \omega y_{i,t-1} + a_1{}'\overline{x}_i + \gamma_i + \varepsilon_{it} \tag{5.9}$$

[31] Although the methodology was originally developed over 30 years ago, it is still used to deal with fixed effects in models, for example by Wooldridge and Papke (2008) who used it to control for unobserved heterogeneity that might be correlated with explanatory variables while estimating the production risk impact on technology adoption, Allanson and Petrie (2013) to model dynamic health changes and Mavromaras *et al*. (2013) in an unemployment study.

$$y_{i1}^* = \lambda' z_i + \theta\gamma_i + \varepsilon_{i1} \tag{5.10}$$

To obtain a single equation model, the approach of Wooldridge (2005) is followed. The author specified an alternative condition maximum likelihood estimator which employs the distribution conditional on the initial value and exogenous variables. That is, instead of specifying the distribution for $\mathrm{P}(y_{i1} \mid \gamma_i)$, Wooldridge specifies $\mathrm{P}(\gamma_i \mid y_{i1})$:

$$\gamma_i = \zeta_0 + \zeta_1 y_{i1} + z_i'\zeta + e_i \tag{5.11}$$

where z_i contains variables which are correlated with the unobservable γ_i. The intuition here is that the correlation between the initial value y_{i1} and the unobservable γ_i is controlled for explicitly, resulting in another specific individual error term e_i that is not correlated with the initial value. Furthermore, if one specifies the means across time of time-varying covariates to be z_i, the final model to estimate becomes:

$$y_{it}^* = x_{it}'\beta + \omega y_{i,t-1} + a_1'\overline{x}_i + \zeta_i y_{i1} + e_i \tag{5.12}$$

where $i = 1,2,\ldots,n$ and t=2,...,T_i.

The final choice of the estimation method will be discussed in the following section, and a robustness check will compare results from the variety of estimators discussed here.

5.4 Empirical section

In the model, income is a function of the economic size of farms as measured by Standard Gross Margin (SGM). The economic size of farms is split into cropping and livestock SGMs. This accounts for the fact that cropping and livestock farming activities are of different nature; they are expected to bring different expected returns with different short-run and long-run dynamics, where the initial impact is likely to be bigger for crop as a proportion of the total long-run impact.

The model is estimated using the OLS method with an addition of explicitly modelling the fixed effects following Mundlak (1978) and Wooldridge (2005) (OLSfe from here on). An appealing feature of this estimator is that the explicitly modelled fixed effects can enter the decomposition of inequality in the next chapter, which will prove quite informative. The robustness of the results to the choice of estimator is investigated thoroughly later on, with the findings providing no evidence against the OLSfe.

The section will start with a discussion of data and variables summary, followed by a description of model specification and model estimation and results. This is concluded with a robustness analysis where the model is estimated across a variety of methods in order to check the sensitivity of results to the assumptions used for different estimators.

5.4.1 Data and variables summary

The analysis is performed using farm-level FAS data for years 1996-2010, which corresponds to 1995/96-2009/10 production years.

Some explanation as to why this period of data differs from the earlier period studied in chapters 3 and 4 is needed, since the redistributive effect analysis (and by association the capitalisation estimation in chapter 3) looks at the support in the production years 2005/2006 – 2009/2010, while the dynamic analysis looks at the period 1995/1996 – 2009/2010. The reason why data from 2006 onwards is used for the first type of analysis is that the interest was in the post-SFP support and income distributions, seeing how Allanson (2008) already analysed the pre-SFP redistributive effect of support. However, for the dynamic analysis, in order to get meaningful estimates of the dynamics in the income model, longer time span is necessary (with the awareness that there might be issues with support regime changes over such a long period, but these are largely controlled by the inclusion of time fixed effects in the model). Furthermore, unlike with the redistributive analysis, no prior investigation of the income mobility of agricultural incomes in Scotland of this type exists and there was interest in using a longer period of data to get a more comprehensive picture. The comparison of pre- and post-SFP data is also achieved with the use of multiyear changes analysis.

Table 5.1 presents the summary of variables used: initial and final incomes, SGM, and the cropping and livestock shares of enterprise mix. Term *initial income* refers to the income in year *t*, and *final income* is the income in *t*+1. The analysis is done on a change in income, therefore the initial and final incomes linked to a given year need to have the same sample size to calculate the change in income. However, the panel is not balanced throughout the years; thus the mean of final income in one year does not correspond to the mean of initial income in the following year as the samples used to calculate them are different.

Table 5.1 Data summary

	Variable	*Number of observation*	*Mean*	*Standard Deviation*	*Minimum*	*Maximum*
All	*Initial income*	6045	37860	36606	-136936	329048
	Final income	6045	37997	37419	-79721	375747
	Standard Gross Margin	6045	66674	50592	1749	414763
	Cropping share of enterprise mix	6045	0.29	0.35	0	1
	Livestock share of enterprise mix	6045	0.71	0.35	0	1
1996	*Initial income*	498	40371	36256	-23061	228581
/1997	*Final income*	498	44834	37212	-79721	258593
	Standard Gross Margin	498	57932	42132	4727	349853
	Cropping share of enterprise mix	498	0.29	0.34	0	1
	Livestock share of enterprise mix	498	0.71	0.34	0	1
1997	*Initial income*	507	45684	36679	-25279	234769
/1998	*Final income*	507	30758	27863	-30113	165227
	Standard Gross Margin	507	59560	43547	5300	343838
	Cropping share of enterprise mix	507	0.28	0.34	0	1
	Livestock share of enterprise mix	507	0.72	0.34	0	1
1998	*Initial income*	506	30147	28482	-136936	157526
/1999	*Final income*	506	30580	28792	-67822	189964
	Standard Gross Margin	506	62131	45708	4759	371368
	Cropping share of enterprise mix	506	0.29	0.35	0	1
	Livestock share of enterprise mix	506	0.71	0.35	0	1
1999	*Initial income*	498	31335	28966	-67822	189964
/2000	*Final income*	498	28063	29026	-44636	191216
	Standard Gross Margin	498	62916	47276	3855	339207
	Cropping share of enterprise mix	498	0.26	0.34	0	1
	Livestock share of enterprise mix	498	0.74	0.34	0	1
2000	*Initial income*	434	27456	28647	-44636	191216
/2001	*Final income*	434	29923	30114	-9835	211964
	Standard Gross Margin	434	62997	45489	6623	375944
	Cropping share of enterprise mix	434	0.28	0.34	0	1
	Livestock share of enterprise mix	434	0.72	0.34	0	1
2001	*Initial income*	364	28178	27742	-64612	182419
/2002	*Final income*	364	33053	33129	-40210	188855
	Standard Gross Margin	364	60862	47062	6364	398376
	Cropping share of enterprise mix	364	0.29	0.35	0	1
	Livestock share of enterprise mix	364	0.71	0.35	0	1
2002	*Initial income*	329	33109	32681	-24194	188855
/2003	*Final income*	329	32420	28792	-33721	174710
	Standard Gross Margin	329	60966	48468	1749	376453
	Cropping share of enterprise mix	329	0.28	0.34	0	1
	Livestock share of enterprise mix	329	0.72	0.34	0	1
2003	*Initial income*	332	34485	28504	-33721	174710
/2004	*Final income*	332	38806	32273	-56801	202260
	Standard Gross Margin	332	65882	49131	6043	383280
	Cropping share of enterprise mix	332	0.30	0.35	0	1
	Livestock share of enterprise mix	332	0.70	0.35	0	1
2004	*Initial income*	424	40281	33700	-56801	207943
/2005	*Final income*	424	40327	35467	-21985	208680
	Standard Gross Margin	424	69621	52725	6007	373628
	Cropping share of enterprise mix	424	0.29	0.35	0	1
	Livestock share of enterprise mix	424	0.71	0.35	0	1
2005	*Initial income*	437	40157	35693	-40095	208680
/2006	*Final income*	437	34173	32050	-48030	176977
	Standard Gross Margin	437	70843	53256	5899	413278
	Cropping share of enterprise mix	437	0.28	0.35	0	1
	Livestock share of enterprise mix	437	0.72	0.35	0	1
2006	*Initial income*	426	34115	31862	-48030	176977
/2007	*Final income*	426	37051	37508	-30575	293141
	Standard Gross Margin	426	70792	51185	5333	305395
	Cropping share of enterprise mix	426	0.29	0.35	0	1
	Livestock share of enterprise mix	426	0.71	0.35	0	1
2007	*Initial income*	415	37977	37910	-30575	293141
/2008	*Final income*	415	50367	50635	-37996	323733
	Standard Gross Margin	415	73664	53444	6638	312027
	Cropping share of enterprise mix	415	0.29	0.35	0	1
	Livestock share of enterprise mix	415	0.71	0.35	0	1
2008	*Initial income*	421	51613	51235	-46727	323733
/2009	*Final income*	421	49637	48037	-40250	329048
	Standard Gross Margin	421	77056	59692	5378	414763
	Cropping share of enterprise mix	421	0.30	0.36	0	1
	Livestock share of enterprise mix	421	0.70	0.36	0	1
2009	*Initial income*	454	51916	50637	-40250	329048
/2010	*Final income*	454	53173	49713	-41772	375747
	Standard Gross Margin	454	79635	61568	5038	352254
	Cropping share of enterprise mix	454	0.34	0.38	0	1
	Livestock share of enterprise mix	454	0.66	0.38	0	1

The income measure used is Cash Income, as defined in chapter 4. Like earlier for the purpose of the redistributive effect analysis, this measure is chosen as it seems to be the best representative of what is available to farmers for their spending purposes and therefore it corresponds closely to the income position as perceived by a farmer. Since the purpose of estimating the model is to complement the mobility analysis in the following chapter, it is important to use a consistent measure of income throughout.

The variable used to measure economic size of farms is the SGM of a farm; this concept is measured in pounds and is closely related to the Economic Size Units (ESU) (with 1 ESU being equal to 1200 SGM in euros). The role of the SGM in the model is to capture income-generating capacity of farms. The concept of SGM is used in the Farms Structure Survey organized by Eurostat, in the European Commission's Farm Accounting Data Network and in the Scottish Government's Farm Accounts Survey. According to the European Commission's website "the Standard Gross Margin (SGM) of a crop or livestock item is defined as the value of output from one hectare or from one animal less the cost of variable inputs required to produce that output" (European Commission, 2011a). The Scottish Government further states that "enterprise output is revenue adjusted for valuation change, plus transfers out and the value of produce used, less transfers in and purchases. Variable costs are those that can be readily allocated to an enterprise and vary in proportion to the size of the enterprise" (SGRERAD, 2011, p. 89).

All crop and livestock items have SGM figures calculated based on empirical data collected from the farms, averaged across 4 years. The SGM figures are updated, although not very frequently. Even so, the weights changed twice in the sample period, in 1999 and in 2004, therefore the SGM variable used for estimation in this model was adjusted by recalculating the figures for the whole sample period using the latest set of weights for consistency.

The shares of enterprise mix are calculated as a ratio of livestock and cropping SGM to overall SGM. As can be seen, livestock share is consistently higher than cropping. This implies the dominance of livestock enterprises in the Scottish agriculture. Based on these shares, the cropping and livestock SGM values are calculated.

The model is quite simple in the fact that it does not include any additional explanatory variables other than the SGM. Any attempts to develop a more complex model failed to provide a statistically robust specification. In particular, experiments with modelling income as a production function, using factors of production like land, labour and capital, were unsatisfactory. This could be because the input measures which are relevant are hard to define and they might be highly correlated, causing collinearity among the covariates. Consequently, the SGM figure serves as a type of black box for the agricultural production function.

One weakness of using the SGM is that the relationship of income to SGM will be mediated by whether the farmer provides all the land and labour, as the SGM variable does not take into account the ownership of factors of production. Assuming a given farm is roughly of fixed size over the period, then this should be to some extent controlled by the fixed effect.

5.4.2 Empirical model specification

In addition to farm fixed effects, the model further includes time fixed effects. Factors like market events, weather conditions or disease outbreaks impact the relationship between the economic size of farms and income. These factors will vary between years, therefore it is important to account for that impact in the model. A simple way to do this is to include in the model year dummies which capture shifts in average income between years. However, such intercept dummies would not account for the fact that the impact of common shocks in any given year on a farm's income generating capacity will be dependent on the farm's economic size (whether the year is good or bad, its impact on farms' income will be proportional to the farms' size). Therefore instead of intercept dummies, the model includes slope dummies, where year dummies are interacted with farms' SGM measure (split into livestock and cropping shares) to account for the differences in the impact of time fixed effects on farms of different sizes. The conditions in a given year are incorporated in the long-run relationship as a type of technological change.

In the ADLM specification, the model is of the following form[32]:

$$\begin{aligned}
Income_{i,t+1} = {} & \alpha_0 + \delta_1(cropping\ SGM)_{i,t+1} + \delta_2(livestock\ SGM)_{i,t+1} + (1-\lambda)\ income_{i,t} \\
& + \alpha_1(cropping\ SGM)_{i,t} + \alpha_2(livestock\ SGM)_{i,t} + \alpha_3(fixed\ effect)_i \qquad (5.13) \\
& + \alpha_4[time\ fixed\ effect*(cropping\ SGM)_{i,t}] + \alpha_5[time\ fixed\ effect*(livestock\ SGM)_{i,t}] \\
& + \varepsilon i_{,t+1}
\end{aligned}$$

δ's are the short-run impact parameters.

[32] For simplicity, only term *fixed effect* enters the model specification, where in reality this consists of the means of livestock and cropping SGMs for farm *i* across time and the initial value of income $y_i 1$ (where contributions from the three elements are combined into a single factor in the decompositions procedures in chapter 6). Likewise, for simplicity the term *time fixed effect* is combined in the presentation of the model, whereas in reality in consists of 13 annual dummies.

This can easily be converted into an ECM:

$$\begin{aligned}&\textit{Change in income}_{i,t+1} = \alpha_0 + \delta_1(\textit{change in cropping SGM})_{i,t+1} + \\ &\delta_2(\textit{change in livestock SGM})_{i,t+1} + \lambda\{\beta_0 + \beta_1(\textit{cropping SGM})_{i,t} + \\ &\beta_2(\textit{livestock SGM})_{i,t} + \beta_3(\textit{fixed effect}) + \beta_4[\textit{time fixed effect}^*(\textit{cropping SGM})_{i,t}] \\ &+ \beta_5[\textit{time fixed effect}^*(\textit{livestock SGM})_{i,t}] - \textit{income}_{i,t}\} + \varepsilon_{i,t+1}\end{aligned} \qquad (5.14)$$

In the ECM version of the model, βs are the long-run equilibrium parameters and λ is the adjustment parameter, which shows how quickly any deviation from the equilibrium relationship gets adjusted the following period. $\beta_0 = \alpha_0/\lambda$, $\beta_1 = (\alpha_1 + \delta_1)/\lambda$, $\beta_2 = (\alpha_2 + \delta_2)/\lambda$, $\beta_3 = \alpha_3/\lambda$, $\beta_4 = \alpha_4/\lambda$ and $\beta_5 = \alpha_5/\lambda$ may be interpreted as the parameters of the long-run, or equilibrium, income:

$$\begin{aligned}&\textit{Equilibrium income}_t = \beta_0 + \beta_1(\textit{cropping SGM})_{i,t} + \beta_2(\textit{livestock SGM})_{i,t} + \\ &\beta_3(\textit{fixed effect})_i + \beta_4[\textit{time fixed effect}^*(\textit{cropping SGM})_{i,t}] \\ &+ \beta_5[\textit{time fixed effect}^*(\textit{livestock SGM})_{i,t}]\end{aligned} \qquad (5.15)$$

5.4.3 Model estimation results

Table 5.2 presents the estimation results for the model, which is estimated as an ADLM model (the results can easily be converted into ECM following equations (5.1) and (5.2)), using robust standard errors which correct for presence of heteroscedasticity and autocorrelation, given tests which indicated the presence of both. Table 5.3 includes the converted parameters for short-run and long-run dynamics.

Table 5.2 Model estimation results.

Dependant variable: Income

Regressors	*Coefficent*	*Robust standard error*	*t statistic*	*P-value*	*95% Confidence Interval*	
Cropping SGM	0.1227508	0.0650281	1.89	0.059	-0.0047277	0.2502292
Livestock SGM	0.1188032	0.0676287	1.76	0.079	-0.0137733	0.2513797
Lagged income	0.5062783	0.022247	22.76	0	0.4626663	0.5498904
Lagged cropping SGM	-0.0119307	0.107869	-0.11	0.912	-0.2233925	0.1995312
Lagged livestock SGM	0.1724829	0.0700516	2.46	0.014	0.0351566	0.3098091
Mean of cropping SGM	-0.0070596	0.0663679	-0.11	0.915	-0.1371645	0.1230453
Mean of livestock SGM	0.0044285	0.0543378	0.08	0.935	-0.102093	0.1109499
Initial value of income	0.1775035	0.01945	9.13	0	0.1393746	0.2156325
*1997 dummy*lagged cropping SGM*	-0.2327098	0.0916536	-2.54	0.011	-0.4123837	-0.0530359
*1998 dummy*lagged cropping SGM*	0.0064753	0.0915255	0.07	0.944	-0.1729475	0.1858981
*1999 dummy*lagged cropping SGM*	0.0391003	0.0894026	0.44	0.662	-0.1361608	0.2143614
*2000 dummy*lagged cropping SGM*	-0.0363582	0.0916893	-0.4	0.692	-0.2161021	0.1433856
*2001 dummy*lagged cropping SGM*	-0.0891226	0.0930266	-0.96	0.338	-0.2714881	0.093243
*2002 dummy*lagged cropping SGM*	-0.0285313	0.0918958	-0.31	0.756	-0.2086801	0.1516175
*2003 dummy*lagged cropping SGM*	0.0516125	0.0877245	0.59	0.556	-0.1203591	0.223584
*2004 dummy*lagged cropping SGM*	-0.0867424	0.0928873	-0.93	0.35	-0.2688348	0.0953501
*2005 dummy*lagged cropping SGM*	-0.0925019	0.0890868	-1.04	0.299	-0.267144	0.0821402
*2006 dummy*lagged cropping SGM*	0.1477655	0.0981819	1.51	0.132	-0.0447061	0.3402372
*2007 dummy*lagged cropping SGM*	0.3355552	0.0905688	3.7	0	0.1580078	0.5131026
*2008 dummy*lagged cropping SGM*	-0.1419399	0.1067794	-1.33	0.184	-0.3512657	0.0673859
*2009 dummy*lagged cropping SGM*	0.0482231	0.095559	0.5	0.614	-0.1391068	0.235553
*1997 dummy*lagged livestock SGM*	-0.2617652	0.0283901	-9.22	0	-0.3174199	-0.2061104
*1998 dummy*lagged livestock SGM*	-0.2090543	0.0282816	-7.39	0	-0.2644964	-0.1536123
*1999 dummy*lagged livestock SGM*	-0.296366	0.0260359	-11.38	0	-0.3474057	-0.2453263
*2000 dummy*lagged livestock SGM*	-0.1736948	0.0354237	-4.9	0	-0.2431379	-0.1042516
*2001 dummy*lagged livestock SGM*	-0.010069	0.0349788	-0.29	0.773	-0.0786401	0.0585021
*2002 dummy*lagged livestock SGM*	-0.2220153	0.0348529	-6.37	0	-0.2903394	-0.1536911
*2003 dummy*lagged livestock SGM*	-0.1113209	0.0331103	-3.36	0.001	-0.176229	-0.0464129
*2004 dummy*lagged livestock SGM*	-0.0936619	0.0309948	-3.02	0.003	-0.1544228	-0.032901
*2005 dummy*lagged livestock SGM*	-0.2174592	0.0315552	-6.89	0	-0.2793186	-0.1555997
*2006 dummy*lagged livestock SGM*	-0.1688608	0.0302334	-5.59	0	-0.2281292	-0.1095924
*2007 dummy*lagged livestock SGM*	-0.056255	0.0357209	-1.57	0.115	-0.1262808	0.0137709
*2008 dummy*lagged livestock SGM*	-0.0422359	0.037112	-1.14	0.255	-0.1149888	0.0305169
*2009 dummy*lagged livestock SGM*	-0.0871393	0.0423794	-2.06	0.04	-0.1702181	-0.0040605
Constant	2300.301	516.8706	4.45	0	1287.049	3313.553
Wooldridge test for autocorrelation in panel data	*Breusch-Pagan / Cook-Weisberg test for heteroskedasticity*				*Observations*	*6045*
Ho: No first-order autocorrelation	*Ho: Constant variance*				*F(16, 6025)*	*139.68*
	Variables: fitted values of dependant variable				*Prob>F*	*0*
F(1,647)=210.868	Chi2(1)=2708.83				*R-squared*	*0.6451*
Prob>F=0.000	Prob>chi2=0.000				*Root MSE*	*22356*

The lambda in the model is 0.493, which means that slightly under a half of the gap between any farm's actual and equilibrium incomes in a given year is closed the following year.

The short-run impact of change in the economic size of cropping enterprises is 0.123, implying that, on average, for every additional pound of increase in the economic size of cropping enterprises as measured by SGM, the instantaneous return that goes towards farmer's income is 12.3 pence. For livestock enterprises, the corresponding figure is

0.119. This indicates that farms‘ short-run returns from changes in the sizes of both types of enterprises are very similar.

Long-run returns of SGM from cropping and livestock enterprises that go towards farmers’ incomes will vary depending on the year, as a result of the time fixed effects. Wald test was performed to test the joint significance off all the slope dummies. While not all of them are statistically significant individually, the null hypothesis of no joint significance was rejected with P-value of 0.00. There are substantial differences in the annual returns, as shown by the wide dispersion of the long-run coefficients on the economic size variables, reflecting the high variability of farming prices and the impact of weather and disease outbreaks on production levels, and hence consequent unpredictability of farmers’ incomes.

For cropping inputs, the average equilibrium return across all the years is 0.21 and the coefficient of variation, showing relative variability, is 1.3, which indicates very high-variance distribution. Most of the years have positive coefficients, which is in line with economic theory – expansion of the economic size of enterprise is expected to have a positive impact on farmer’s equilibrium income. However, the result is highly negative in 1997[33] (-0.24) and slightly negative (-0.06) in 2008. This implies that economic conditions in these years made cropping unprofitable, and the larger the enterprise, the bigger were the losses. The Scottish Governments economic reports show that these results reflect negative market conditions; in 1997 world commodity prices were in

[33] The robustness of this result was checked by estimating the model across different time horizons, for example, eliminating the first year of the sample and changing the base year of the model. This sensitivity analysis confirmed the result that the long-term return for 1997 is highly negative. The coefficient on the dummy for this year is also statistically significant at 5% level, unlike the 2008 which also resulted in negative long-run return.

general low and in 2008 this was caused by steep decline in returns from cereal (SEERAD, 2001; SGRERAD, 2009). 2007 was the best year for cropping, with long -

Table 5.3 Short-run and long-run coefficients.

Regressors	*Coefficent*
Lambda	0.4937217
Short run impact	
Cropping SGM	0.1227508
Livestock SGM	0.1188032
Long run/equilibrium	
1996 Cropping SGM	0.22445864
1997 Cropping SGM	-0.2468794
1998 Cropping SGM	0.23757392
1999 Cropping SGM	0.30365366
2000 Cropping SGM	0.15081756
2001 Cropping SGM	0.04394682
2002 Cropping SGM	0.16667041
2003 Cropping SGM	0.32899627
2004 Cropping SGM	0.04876776
2005 Cropping SGM	0.03710228
2006 Cropping SGM	0.52374769
2007 Cropping SGM	0.90410306
2008 Cropping SGM	-0.0630311
2009 Cropping SGM	0.32213127
1996 Livestock SGM	0.58998035
1997 Livestock SGM	0.05979259
1998 Livestock SGM	0.16655496
1999 Livestock SGM	-0.010289
2000 Livestock SGM	0.23817325
2001 Livestock SGM	0.56958627
2002 Livestock SGM	0.14030333
2003 Livestock SGM	0.36450737
2004 Livestock SGM	0.40027449
2005 Livestock SGM	0.14953141
2006 Livestock SGM	0.24796419
2007 Livestock SGM	0.47603964
2008 Livestock SGM	0.50443438
2009 Livestock SGM	0.41348557
Constant	4659.10451

run return to farmers' income of 90 pence for every pound of economic size of cropping enterprises. The corresponding economic report on agriculture (SEERAD, 2008) notes that this year was particularly good for cereals, given a good harvest and high global prices.

The average long-run return for livestock activity is 0.31 and the coefficient of variation is 0.63. Two interesting observations emerge from that finding. Firstly, the long-run correction relative to short-run return is bigger for livestock than for cropping, with 19 and 9 pence average adjustment respectively. This implies that the share of the long-term return to livestock that is realized in the short run is smaller than for cropping. This seems plausible from an agronomic point of view as the short-run returns to investment in livestock will be lower than for cropping given the nature of the livestock production cycle. Secondly, the higher coefficient of variation for crop returns indicates higher instability of markets for cropping, with less predictability of future returns for cropping farmers. Investigation of market conditions in that period revealed that the high variability is due more to price instability rather than output variation (SGRERAD, 2008).

Only 1999 shows negative return for livestock, but it is very close to zero and insignificant. The low return from livestock is presumably due to the Bovine spongiform encephalopathy (BSE) disease outbreak which started in the few preceding years (SEERAD, 2001). Highest long-run returns were in 1996, with 59 pence per pound increase in the economic size of livestock activity (although the year was not particularly good for either type of production, there was in increase in agricultural land use for rough grazing and sharp increase in numbers of cattle (SEERAD, 2002)) and 57 pence in 2001 (which reflected positive price trends and volumes for livestock sector recovering from Foot-and-Mouth Disease (FMD) outbreak in the previous year).

5.4.4 Robustness check

In order to test the robustness of results, the model was also estimated using the other possible estimators identified in section 5.3: Ordinary Least Squares (OLS), Fixed Effects (FE), Arellano-Bond (AB), Blundell-Bond (BB), and bias-corrected Least Square Dummy Variable (LSDVC).

For robustness check results are generated for all estimators based on identical sample, which is slightly different to the sample used for the final specification in the preceding section, since the GMM estimators automatically restrict the sample due to differencing of data (as does LSDVC since it is based on BB estimators); thus the restricted sample consists of 5080 observations. For comparison, a new set of OLSfe estimates based on the corresponding sample is included. The results are presented in Table 5.2.

Starting with the OLS estimation method, the results show a relatively large coefficient on lagged income, which implies a correspondingly low lambda parameter. In this case lambda would be (1-0.62) = 0.38, indicating that about 38% of disequilibrium from a previous period is fixed in the following one. Due to the correlation of the dependant variable and composite error term, which includes individual effects, this result is likely to be biased upwards. Therefore one can expect that the coefficient on lagged income ($1-\lambda$) in the ADLM specification of the model is higher than the true value of the parameter and that the true lambda is therefore somewhat higher, and consequently the rate of adjustment is faster.

Table 5.4 Comparison of estimation results across different estimators[34].

	OLS	*FE*	*AB*	*BB*	*LSDVC*	*OLSfe*
Lagged income	**0.619*****	**0.0571*****	**-0.100***	**0.0928***	**0.182*****	**0.520*****
	0.021	*0.017*	*0.044*	*0.044*	*0.029*	*0.023*
Cropping SGM	**0.162***	**0.104***	**0.128**	**0.260*****	**0.0990*****	**0.121**
	0.069	*0.043*	*0.079*	*0.064*	*0.006*	*0.072*
Livestock SGM	**0.177***	**0.171*****	**0.155***	**0.305*****	**0.164*****	**0.171***
	0.074	*0.037*	*0.069*	*0.074*	*0.031*	*0.081*
Lagged cropping SGM	**-0.255****	**-0.109***	**-0.062**	**-0.078**	**-0.166****	**-0.298*****
	0.084	*0.051*	*0.091*	*0.091*	*0.058*	*0.088*
Lagged livestock SGM	**-0.114**	**0.063**	**0.099**	**0.073**	**0.004**	**-0.118**
	0.077	*0.042*	*0.113*	*0.078*	*0.033*	*0.073*
*1998 dummy*lagged cropping SGM*	**0.268*****	**0.067**	**0.027**	**0.112***	**0.105*****	**0.243*****
	0.062	*0.035*	*0.034*	*0.046*	*0.023*	*0.061*
*1999 dummy*lagged cropping SGM*	**0.304*****	**0.149*****	**0.115***	**0.178****	**0.180*****	**0.296*****
	0.062	*0.036*	*0.051*	*0.062*	*0.024*	*0.059*
*2000 dummy*lagged cropping SGM*	**0.217*****	**0.117*****	**0.090**	**0.136****	**0.139****	**0.216*****
	0.058	*0.035*	*0.052*	*0.050*	*0.050*	*0.060*
*2001 dummy*lagged cropping SGM*	**0.167***	**0.064**	**0.028**	**0.080**	**0.0895*****	**0.160***
	0.066	*0.037*	*0.057*	*0.068*	*0.022*	*0.063*
*2002 dummy*lagged cropping SGM*	**0.232*****	**0.0762***	**0.045**	**0.101**	**0.110*****	**0.219*****
	0.064	*0.038*	*0.059*	*0.067*	*0.000*	*0.061*
*2003 dummy*lagged cropping SGM*	**0.276*****	**0.147*****	**0.138***	**0.167****	**0.179*****	**0.281*****
	0.057	*0.038*	*0.061*	*0.063*	*0.002*	*0.055*
*2004 dummy*lagged cropping SGM*	**0.139***	**0.049**	**0.054**	**0.065**	**0.0712*****	**0.153***
	0.066	*0.036*	*0.066*	*0.066*	*0.012*	*0.065*
*2005 dummy*lagged cropping SGM*	**0.145****	**0.000**	**-0.002**	**0.032**	**0.035**	**0.156****
	0.054	*0.036*	*0.068*	*0.060*	*0.018*	*0.056*
*2006 dummy*lagged cropping SGM*	**0.407*****	**0.226*****	**0.199***	**0.261****	**0.272*****	**0.413*****
	0.078	*0.038*	*0.078*	*0.081*	*0.003*	*0.075*
*2007 dummy*lagged cropping SGM*	**0.573*****	**0.508*****	**0.522*****	**0.537*****	**0.527*****	**0.601*****
	0.062	*0.037*	*0.079*	*0.069*	*0.015*	*0.059*
*2008 dummy*lagged cropping SGM*	**0.103**	**0.200*****	**0.255****	**0.212***	**0.182*****	**0.163**
	0.091	*0.037*	*0.097*	*0.095*	*0.041*	*0.089*
*2009 dummy*lagged cropping SGM*	**0.280*****	**0.194*****	**0.231****	**0.219****	**0.217*****	**0.305*****
	0.066	*0.035*	*0.071*	*0.072*	*0.043*	*0.064*
*1998 dummy*lagged livestock SGM*	**0.0821****	**-0.027**	**-0.055**	**0.008**	**-0.002**	**0.0602***
	0.028	*-0.026*	*-0.021*	*0.026*	*-0.003*	*0.027*
*1999 dummy*lagged livestock SGM*	**-0.011**	**-0.145*****	**-0.176*****	**-0.110*****	**-0.114*****	**-0.035**
	-0.026	*-0.025*	*-0.026*	*-0.028*	*-0.007*	*-0.025*
*2000 dummy*lagged livestock SGM*	**0.126*****	**-0.0708****	**-0.124*****	**-0.031**	**-0.026**	**0.0911****
	0.035	*-0.027*	*-0.036*	*-0.039*	*-0.075*	*-0.035*
*2001 dummy*lagged livestock SGM*	**0.285*****	**0.0924****	**0.0802***	**0.158*****	**0.129*****	**0.251*****
	0.036	*0.029*	*-0.037*	*0.036*	*0.008*	*0.034*
*2002 dummy*lagged livestock SGM*	**0.047**	**-0.022**	**-0.014**	**0.033**	**-0.010**	**0.036**
	0.036	*-0.029*	*-0.041*	*0.040*	*-0.011*	*0.034*
*2003 dummy*lagged livestock SGM*	**0.187*****	**0.045**	**0.035**	**0.104****	**0.0712****	**0.166*****
	0.035	*0.030*	*0.045*	*0.039*	*0.024*	*0.033*
*2004 dummy*lagged livestock SGM*	**0.203*****	**0.104*****	**0.0993***	**0.142*****	**0.124*****	**0.191*****
	0.034	*0.028*	*0.047*	*0.040*	*0.014*	*0.033*
*2005 dummy*lagged livestock SGM*	**0.049**	**-0.015**	**-0.016**	**0.018**	**0.000**	**0.044**
	0.032	*-0.026*	*-0.048*	*0.038*	*0.011*	*0.031*
*2006 dummy*lagged livestock SGM*	**0.112*****	**-0.009**	**-0.025**	**0.022**	**0.019**	**0.0968****
	0.031	*-0.026*	*-0.050*	*0.039*	*0.032*	*0.030*
*2007 dummy*lagged livestock SGM*	**0.207*****	**0.0869*****	**0.076**	**0.117****	**0.115****	**0.194*****
	0.038	*0.026*	*0.056*	*0.045*	*0.038*	*0.037*
*2008 dummy*lagged livestock SGM*	**0.210*****	**0.141*****	**0.144***	**0.167*****	**0.160*****	**0.211*****
	0.036	*0.026*	*0.058*	*0.043*	*0.047*	*0.036*
*2009 dummy*lagged livestock SGM*	**0.160*****	**0.141*****	**0.149***	**0.168****	**0.147*****	**0.171*****
	0.044	*0.026*	*0.064*	*0.052*	*0.008*	*0.042*
Mean of cropping SGM	-	-	-	-	-	**0.016**
						0.071
Mean of livestock SGM	-	-	-	-	-	**-0.036**
						-0.066
Initial value of income	-	-	-	-	-	**0.196*****
						0.021
Constant	**2535.2*****	**20416.1*****	**24406.7*****	**6645.8*****	-	**1860.1*****
	578.9	*1753.4*	*6525.2*	*1575.7*		*537.0*
Sample size	5080	5080	5080	5080	5080	5080
R-squared	0.629	0.167	-	-	-	0.647
F	118	30	-	-	-	123
AIC	116311	114056	-	-	-	116058

[34] Coefficients are in bold and standard errors are in small print under the estimates. Statistical significance at 1%, 5% and 10% are denoted respectively as ***, **, *.

The Fixed Effects estimator, on the other hand, produces a very low coefficient on lagged income, implying a value of lambda equal to 0.94 - an almost full immediate correction of any disequilibrium from the previous period. According to theory, the correlation between the transformed dependant variable and the transformed error term in this estimation method will lead to a downward bias in the estimate of $(1- \lambda)$. As such, the true value of λ is expected to be less than 0.94.

AB estimation did not produce a suitable result, mainly because the coefficient on the lag of income was negative, which would translate into a lambda coefficient greater than 1. Furthermore, although the model passed the test for no second order autocorrelation in the differenced residuals (the null of no autocorrelation was rejected with P-value of 0.00), it failed the Sargan test of overidentifying restrictions (the null of overidentifying restrictions being valid was rejected with P-value of 0.00).

BB estimator generated coefficients which are more in line with economic intuition; the coefficient on the lagged income is positive, but its value is very low and close to the biased FE result. Furthermore, the model still failed the Sargan test of overidentifying restrictions (the null hypothesis of overidentifying restrictions being valid was rejected with P-value of 0.00). This implies that the model behind this estimator is not valid.

LSDVC estimator[35] produced reasonable results – the coefficient on lagged income is positive. The problem with this estimator is that it assumes strictly exogenous regressors, whereas the SGM variable has to be treated as predetermined, since the

[35] BB was chosen as the preliminary consistent estimator in this case since it performed better than AB.

economic size of farms in a given year is influenced by the size in the preceding years and any shocks to the size are likely to play role in the future size[36].

The last column of the table shows the OLSfe results, with positive coefficient on lagged income and generally comparable values to other methods. The lagged income coefficient from this estimator is between the upper and lower bound of OLS and FE estimators accordingly[37].

The important thing one can see comparing the estimates from the various methods is that all the methods generate comparable results. There is a degree of adjustment of the disequilibrium from the previous period (with the exception of the odd AB result), the coefficients on the current levels of economic size variables are always positive and of comparable magnitude, and the coefficients on the lagged economic size variables together with the slope dummies also show robustness – most of them are positive and comparable, and those that are negative, remain negative across all or most of the estimators[38].

Overall, this robustness check shows the results are roughly consistent across estimators and hence it indicates that the estimates are relatively insensitive to the choice of assumptions implicit in the use of the alternative estimators. Taking into account the known shortcomings of OLS and FE estimators, and the negative lambda result for AB, the choice of the estimator boiled down to three: BB, LSDVC or OLSfe. However, BB failed the Sargan test of validity of the instruments, and LSDVC required strict

---

[36] This is confirmed by Wooldridge (2009) test of exogeneity where future values of SGM have predictive power and are statistically significant when added as regressors to the income model.
[37] The same was true when FE and OLS estimators were used for the full sample used in section 5.4.3.
[38] See for example the Lagged cropping SGM which represents the base year coefficient for 1997, which represents a particularly bad year for crop returns.

exogeneity of the explanatory variables, which is not the case in this model. The OLS method would be an acceptable estimator if it were not for the presence of individual effects in the error term. However, since in the case of OLSfe estimator the fixed effects are explicitly modelled, this removes the correlation between the lagged income and the error term, and should result in an unbiased estimator. The biggest disadvantage of this estimator is the uncertainty as to whether the fixed effects are modelled correctly or not, but it has been shown that the estimator is within the expected bounds as specified by OLS and FE estimators. Lastly, an appealing feature of the OLSfe estimator is that it allows using the largest sample (since no data differencing is necessary), and therefore there is no loss of information.

5.5 Conclusion

The purpose of this chapter was to develop a model which captures the determinants of individual agricultural income changes in Scotland, using farm-level FAS data for production years 1995/96 to 2009/10. The income was modelled as a function of the economic size of farms, which was separated into cropping and livestock activities. The model also included time fixed effects interacted with the economic size variable in order to account for the fact that the impact of conditions in any given year on income will be dependent on the size of the farm.

This type of model is not straightforward to estimate because of the inclusion of lagged dependant variable which is correlated with the error term. In particular, both OLS and FE estimators are biased in this scenario. Popular estimators for this type of models are difference and system GMM, but these are not suitable if the overidentifying restrictions are not valid, which is the case here. Another approach is to compute the correction of the bias in the fixed effects estimator, however the bias-corrected Least Square Dummy Estimator requires the covariates to be strictly exogenous, a condition which is not satisfied by regressors used in this model. An alternative solution is to use OLS but to model the fixed effects following Mundlak's (1978) approach. The weakness of this methodology is the uncertainty about whether the fixed effects are modelled correctly.

In the light of potential shortcomings in all the available methods, the choice of the estimator is somewhat arbitrary. The important thing is that the results of the model are robust across the estimators, indicating that estimates are relatively insensitive to the choice of assumptions implicit in the use of the alternative estimators. Ultimately, the OLS estimator with modelled fixed effects was chosen since it has the appeal of providing explicitly estimates of fixed effects, which will prove useful in the decomposition of equilibrium inequality in the following chapter. Furthermore, this estimator allows using a larger sample than other estimators that require differencing and therefore it eliminates loss of information.

The results indicate that almost half of the annual deviation from the long-run equilibrium income was corrected the following year. The short-run return from changes in the economic size of cropping and livestock enterprises are very similar; on average farmers get 12 pence return in the short run from increasing the economic size of both types of enterprises by one pound. Both types of activities have bigger long-run returns, but the adjustment for livestock is relatively larger. This is in line with the expectations considering the livestock production cycle. The results also indicate larger variation in annual returns for cropping, which is caused by larger fluctuations in the price of crops.

The results from this model of how economic size of cropping and livestock enterprises drives individual income changes will be used in the subsequent chapter to get more insight into the drivers of vertical mobility, as well as to model and quantify the contributions to long-run agricultural income inequality.

6 Income mobility

6.1 Introduction

When agricultural incomes are studied, the attention is most often focused on either the static distributional consequences of support (see section 4.2) or income instability (Hergrenes *et al*., 2001; Hill, 1999; Mishra and Goodwin, 1997; Cordts *et al.*, 1984). Very few studies look at the dynamics of individual farm mobility, that is the movement of farms within the income distribution. To my knowledge, the only study of agricultural income dynamics in Scotland is that of Phimister *et al.* (2004).

Looking at inequality in a dynamic context is important in order to see how inequality changes over time and what is driving these changes. Furthermore, studying the dynamics of incomes allows to determine whether inequalities are a transitory or chronic problem, which will influence implications for policy. While farm income inequality is a negative occurrence, it is less of a policy concern if income mobility level is high, allowing poorer farms to move up in the income distribution. High mobility in this context implies that poverty is a transitory phenomenon and can be seen as an equalizer of opportunity. High income inequality and low income mobility, on the other hand, pose a serious problem for policy makers, indicating that poor farms get stuck at the bottom and cannot move out of the poverty.

Since in most countries a substantial part of farms‘ incomes comes from agricultural support, analysing agricultural income inequality in a dynamic context can be seen as an implicit evaluation of agricultural policy in terms of its impact on inequality over time.

As Fields (2008) points out, *income mobility* denotes different things to different researchers; consequently a broad range of mobility indices, measuring different aspects of mobility, have been created over time. One clear and comprehensive classification of different mobility indices is provided by Jantti and Jenkins (2013) who distinguish four mobility concepts: positional change, individual income growth, reduction of longer-term inequality and income risk.

This chapter will look at the dynamic trends in agricultural income inequality in Scotland in years 1995/1996 – 2009/2010, and it will tackle all four concepts of mobility distinguished by Jantti and Jenkins (*Ibid.*). Inequality trends over time will be characterized and the role of transitory and structural factors in these trends will be determined with the use of Shorrocks rigidity measure, which relates to the concept of mobility as the reduction of longer-term inequality. Furthermore, changes in inequality over time will be decomposed into components due to income growth across the income range, that is vertical mobility, and the reshuffling of individuals in the income distribution, that is reranking mobility. These two measures correspond to the mobility concepts of individual income growth and positional change, respectively. This part of the analysis will allow the investigation of whether relative income changes were progressive or regressive. Additionally, the dynamic model of income from chapter 5 will be used for two purposes. Firstly, to decompose vertical mobility employing a regression-based decomposition procedure in order to see how inequalities in income determinants impact on the pattern of individual income growth. Secondly, to measure the degree of long-run, or structural, inequality (which is linked to the concept of mobility at income risk) and see how income determinants contribute to it. This analysis will be informative about the degree to which the economic size of farms determines their financial performance and as such, to what extent it determines income inequality and changes in it over time.

This chapter investigates a very unexplored area of agricultural income dynamics, particularly in Scotland. Furthermore, the methodology used to decompose the vertical mobility index has never been used outside the context of income-related health inequality (Allanson and Petrie, 2013), and this chapter adds on to the original approach by decomposing changes over multiyear periods.

Section 6.2 provides a literature review on income mobility and Scottish income dynamics, followed by a methodology description in section 6.3 and empirical results in 6.4. The chapter is closed with conclusions in section 6.5.

6.2 Literature review

This section will briefly discuss some approaches to mobility measurement and the existing research on Scottish agricultural income dynamics.

6.2.1 Income mobility

The concept of income mobility is closely linked to the analysis of income inequality and it concerns changes in inequality from one period to another, or one generation to another. As Fields and Ok put it:

> "Static evaluations of income distributions can provide only an incomplete picture, for, in most instances, the social welfare would certainly depend on the dynamics of income distribution as well. This basic insight, along with the increased availability of longitudinal data sets, has led to a massive and rapidly expanding literature on the measurement of income mobility."
>
> (Fields and Ok, 1999, p. 2)

Specifically, inequality at a given point in time is less of a concern for policy makers if high income mobility exists such that those at the bottom of the income distribution have a high chance of climbing up over time.

Fields and Ok (*Ibid.*) further state that in spite of a large body of literature on the measurement of income mobility, it fails to provide a uniform discourse of analysis. As Fields (2008) points out, part of it is caused by the fact that income mobility denotes different things to different researchers; consequently a broad range of mobility indices, measuring different aspects of mobility, have been created over time.

One possible classification of different dimensions of mobility is provided by Jantti and Jenkins (2013). Their clear and comprehensive description distinguishes four mobility concepts: positional change, individual income growth, reduction of longer-term inequality and income risk. Whether more mobility is desirable from a societal point of view depends on the mobility concept in question.

Following Jantti and Jenkins' (*Ibid.*) notations, mobility in general relates to the transformation linking the marginal distribution of $\boldsymbol{x}$ with marginal distribution of $\boldsymbol{y}$, where $\boldsymbol{x}$ and $\boldsymbol{y}$ are incomes vectors of N individuals in first and second periods respectively. They have a bivariate joint density $f(\mathbf{x}, \mathbf{y})$. In general, mobility can be considered as the transformation which links marginal distributions of $\boldsymbol{x}$ and $\boldsymbol{y}$; the different mobility concepts 'standardise' [*sic*] these marginal distributions differently in order to concentrate on the nature of the link between $\boldsymbol{x}$ and $\boldsymbol{y}$.

Positional change specifically concerns mobility which is separate from changes in the shape of marginal distributions between the periods, like an increase in income inequality or average income, or in more general terms, a change in the density of individuals in any given income range. Standardisation to measure such changes is usually done by summarizing each individual's position in terms of their income rank in the population normalized by population size, rather than by income per se, where the marginal distribution of fractional ranks is a standard uniform distribution of $\boldsymbol{x}$ and $\boldsymbol{y}$ by definition. As such, positional change mobility concerns the pattern of exchange of persons between positions (known as *exchange mobility*), separate from any changes in the density of persons at particular points in the income range (known as *structural mobility*). In other words, income changes concern positional mobility only to the extent that they alter each individual's position relative to the position of others. This means that equiproportional income growth across individuals or equal absolute increases to income for each person would raise incomes but cause no mobility in the positional sense. This type of mobility for a specific person necessarily depends on other individuals' positions. As such, if one person changes position, so must at least one other person, and it is impossible for everyone to be upwardly or downwardly mobile. This type of mobility has an upper bound but there are two ways of thinking of the reference points; one relates to the independence of origin and destination, and the other to movement. For the first one, full independence of the origin takes place when the chances of being in the richest tenth of population in the second period are the same for the individuals in the poorest tenth and richest tenth in the first period. The second way emphasizes the positional movement concept per se with the view that maximum mobility occurs when there is a full rank reversal between the periods, so that the poorest person in period 1 is the richest one in period 2, and the richest person in period 1 is the poorest in period 2, etc.

The *individual income growth* concept refers to a measure of income changes (gains or losses) for individuals between two points in time. This concept contrasts with the one of positional movement; the focus is on gross mobility with no distinction between structural and exchange type, and it is possible for everyone to be upwardly or downwardly mobile – positive income growth for all will be considered mobility even if relative positions do not change. In this case, mobility can be defined for each individual as the *distance* between starting and final income. No mobility refers to the case when the measure of distance is zero for each individual, and the greater the distance for everyone, the more mobility there is, *ceteris paribus*. There is no natural maximum mobility due to no obvious upper bound. The choice of distance metric is crucial for this concept of mobility, with the main distinction between different measures concerning whether they take into account *directional* or *non-directional* growth. The former case treats income gains differently to income losses, whereas with the latter a gain and a loss of equal magnitude are given the same distance and are summarized as income *flux* (see Fields and Ok (1999) for more).

The third concept of mobility defines it in the context of *impact on inequality in longer-term incomes*. What Jantti and Jenkins define as the *longer-term income* of each person is the longitudinal mean of incomes in each period, so that in two periods case, the mean is $\frac{1}{2}(x_i + y_i)$. Income in each period is therefore made up of two components: a permanent one that is the longer-term average, and a transitory one which is the deviation from that average. The averaging across years smooths out the variability in incomes and, additionally, the inequality of these averaged incomes is less than the dispersion between individuals' incomes in any period. Mobility is then characterized in terms of the degree to which the inequality is reduced as a result of longitudinal averaging (see Shorrocks, 1978a), and no mobility takes place if every person's income in every period is equal to their long-term average. For this concept, the upper bound of maximum mobility can also be defined and it will correspond to the case when there is inequality in individual periods' incomes but no inequality in long-term average incomes. Like the rank reversal aspect of positional change, this concept of mobility is concerned with movement, but the two concepts use different reference points to evaluate it; the former assesses it using base-period positions, and the latter long-term average incomes.

The concept of *mobility as income risk* is related to that of mobility as reduction of multiperiod inequality, but with the statistical long-term average income replaced by expected future income in each period based on the information in the first period. Given this ex ante behavioural perspective, the transitory elements constitute unexpected idiosyncratic income shocks. As such, the bigger is the dispersion of these shocks across individuals, the larger is the income risk for the population. The interpretation of this measure as income risk gives it a different normative interpretation. In this context, the movement of income over time represents its unpredictability. In spite of the similarities between the last two mobility concepts, the two differ in practice once the income generating process is no longer a sum of a fixed permanent component at individual level and an idiosyncratic transitory component. In order to describe the evolution of permanent and transitory components over time, econometric models are used which makes the descriptions more complicated, resulting in different calculations of expected incomes and deviations from it. Nevertheless, both concepts rely on a distinction between a predictable or steady income element and an unpredictable transitory deviation part.

6.2.2 Scottish agricultural income dynamics

The analysis of the dynamics of agricultural incomes in Scotland is a very unexplored research area. To my knowledge, the only paper looking at these issues is by Phimister *et al*. (2004). The study uses the same dataset as this thesis, Farm Accounts Survey, and looks at the period between 1988/89 and 1999/2000. The authors point out that not much attention had been given to the dynamics of agricultural income inequality, with most previous analysis focusing on variability and stability of aggregate mean income (Hergrenes *et al*., 2001; Hill, 1999; Mishra and Goodwin, 1997; Cordts *et al.*, 1984). These studies showed that aggregate income in unstable over time, but that conclusion is not very informative about the experience of individual farmers. Phimister *et al*. try to close that gap by answering the following questions: how mobile are individual farms within the income distribution? What is the proportion of farms that are stuck at the bottom of the distribution? Are there specific farm characteristics that affect the probability of a farm moving in or out of the bottom?

The authors analyse trends in inequality using the Gini coefficient and coefficient of variation calculated for subperiods in the sample, as well as based on averages calculated using a rolling two-year average of individual farm incomes across the sample period in order to smooth out intertemporal fluctuations. Income mobility is measured using relative rather than absolute levels of income in order to differentiate between movements in income associated with the agricultural business cycles and movements of individual farms within the income distribution. Those farms falling in the lowest fifth of the income distribution are defined as low-income farms. Transition matrices and transition rates are used to analyse the extent of movement of farms between income groups from one year to another. Low income persistence is looked at by counting the number of times any given farm is in the poorest income group within a 6-year period. Furthermore, Phimister *et al*. model low-income exit and entry. They employ the proportional hazard model to see if there exists a systematic relationship between spells of low income and certain farm characteristics. The information included in FAS allows them to investigate characteristics like farm size, farm type, tenure type, regional effects and farmer's age.

The conclusions of their study indicate high income variability and mobility. The exit rates from low income/ re-entry into low income decline as the spell in/out of low income persists, but they remain substantial even after a couple of years. Nevertheless, there is evidence of some persistence in poverty and of certain farms being stuck in a poverty trap (around 10% of farms will spend 4 or more years in the low income group in a 6-year period). Farm characteristics that increase the probability of long low-income spells are small size of farms (in terms of the economic size) and age of farmers (being over 60 years old). No significant relationships between farm type or tenure type and low income spells persistence were found.

6.3 Methodology

This section presents the methodology used in this chapter. It starts with the definition of inequality measure used and a discussion on Gibrat's (1931) law of proportionate effect, followed by a description of Shorrock's rigidity index which addresses mobility as reduction of longer-term inequality; it moves on to discuss the approach to measure positional mobility and individual income growth, with the extension of decomposing the measure of individual income growth using a regression-based like procedure. The last subsection discusses a regression-based decomposition of the Gini coefficient of chronic inequality, which is linked to measurement of mobility as income risk.

6.3.1 Choice of inequality measure

The inequality measure used in the subsequent analysis is the Gini coefficient. If G_t is the Gini coefficient of incomes in period t, it can be written as:

$$G_t = \frac{2}{\bar{y}_t}\operatorname{cov}(y_t, R_t) \tag{6.1}$$

where y_t is the income in period t, $\bar{y}_t$ is the average income in period t; $R_t \equiv F(y_t)$ signifies the fractional income rank, determined by the cumulative distribution function $F(\cdot)$ of income y_t.

While chapter 4 focused on absolute inequality implications of agricultural support's redistributive effect, this chapter focuses on relative inequality[39]. Looking at relative

[39] The technical difficulty of using the Gini coefficient from chapter 4 no longer applies here, since the earlier problem concerned the presence of negative mean incomes. However, in the case here the mean income by which the Gini coefficient is normalized will always be positive (in chapter 4 it was the pre-

income changes is more meaningful since the level of income changes between years for a given farm will be affected by that farm's income levels; therefore the concept of relative income changes is a more appropriate benchmark for what is expected to be seen.

Furthermore, the relative measure of inequality indirectly ties with Gibrat's law of proportionate effect through the concept of neutral income growth process[40] (in relation to income change decomposition following Jenkins and van Kerm (2006) discussed in section 6.3.3). If Gibrat's law (1931) of proportionate effect holds, it will imply that (expected) income growth is distributionally neutral, providing a natural benchmark or null hypothesis for the evaluation of the redistributive properties of actual income growth processes.

A number of studies have directly investigated whether Gibrat's law holds for farms' growth, with some rejecting its validity (Bakucs & Ferto, 2009; Weiss, 1998, 1999; Shapiro *et al*. 1987), and others failing to find evidence to reject it (Bremmer *et al.,* 2012; Upton and Haworth, 1987). Of particular relevance for the analysis in this chapter are the findings of Bakucs *et al*. (2013) who used quantile regression on panel data from Farm Accountancy Data Network (FADN) for France, Hungary and Slovenia, distinguishing between dairy and crop farms. The novelty of their research is that it compares the validity of Gibrat's law for three countries which have different historical trajectories of agricultural sector development. In particular, Hungary and Slovenia are

support income that had a negative mean, but the income measure used in this chapter corresponds to the post-support income whose average is consistently positive).

[40] In this context, farm income is treated as a size measure. As Kostov *et al*. (2008) point out, a wide range of different variables has been used as size measure in papers studying Gibrat's law, including farmed acreage, livestock numbers, net worth, gross sales, total gross margins and net income (Allanson, 1992; Clarke *et al*. 1992; and, Shapiro *et al*. 1987)

transition countries, whereas France is a non-transition country where market forces and policy support, especially from CAP, have shaped the development of the agricultural industry over an extended period. Their results strongly reject the validity of Gibrat's law for both types of farms in Hungary; the outcome depends on the size proxy for Slovenia (they show divergence for land and livestock size and convergence for Annual Work Units[41]) and the results confirm the law for crop and dairy farms in France. The authors conclude that the differences between the countries are caused by their historical developments. In Hungary and Slovenia farm growth is not independent from farm size since "farming structures had been frozen during the communist period and started evolving again during the transition period" (*Ibid.,* p. 878); this is particularly the case in Hungary which over the transition period developed a bi-modal structure of small family farms and large (mainly corporate) farms and the results indicate that the small farms are catching up in terms of size. The validity of Gibrat's law for French farms comes from the continuity of the market and policy environment, and therefore the French agriculture achieved what the authors refer to as "maturity and steadiness of farm size-farm growth equilibrium" (*Ibid.*, p. 880). In Scotland the farm structure has been shaped similarly to France, therefore the validity of Gibrat's law in Scotland would be consistent with the findings of Bakucs *et al*., implying an equilibrium relationship between farms size and income growth in Scottish agriculture with growth rates uniform across all farm sizes.

[41] One unit corresponds to the work performed by one person engaged in a full-time occupation on agricultural holding (European Commission, 2012).

6.3.2 Shorrocks rigidity measure

The degree of inequality in each year will be affected not only by the underlying long-run factors but also by random shocks to individual farms' incomes in a given year. The Shorrocks rigidity index helps to identify the impact of transitory shocks on income inequality and hence the extent of inequality in the longer-term incomes. This measure corresponds to the concept of mobility as reduction of longer-term inequality, as distinguished by Jantti and Jenkins (2013).

Shorrocks (1978a) developed the concept of mobility as the degree to which equalization occurs when the study period is lengthened. He saw mobility as the opposite of rigidity, which he defined as

$$R_T = \frac{G_T}{\sum_t w_t G_t} \tag{6.2}$$

where $t=1,\ldots,T$, G_T is the Gini coefficient calculated using the average annual income of each individual over all T periods (i.e. longer-term average income), G_t is the Gini coefficient for incomes in year t, and $w_t = \mu_t / \mu_T$, where μ_t is average income in year t (averaged across all individuals) and μ_T is the corresponding average for the T periods.

The index is equal zero if incomes are exactly equalised by the extension of the measurement period, in which case G_T is equal zero; that is if the longer-term averages are equal for everyone in the population, there will be no inequality and the corresponding Gini coefficient will be zero. The index will be equal 1 if relative incomes remain constant over time (the T-period Gini and all the annual Gini coefficients are equal). Therefore, an index value close to zero implies inequality is largely driven by transitory shocks and is more of a short-term phenomenon; values closer to 1 imply more rigidity in the sense that inequality is largely due to long-term differences between farms. The index also has a simple interpretation as the proportion of cross-sectional inequality which persists as the measurement period is extended (Rohde *et al*., 2010).

6.3.3 Decomposition of inequality change

This part of methodology is based on the measurement of inequality change developed by Jenkins and Van Kerm (2006).

When we look at a change in income inequality between two points in time, two elements can be extracted; reshuffling of individuals within the income pecking order, and growth or contraction of the income (Fields and Ok, 1996). In particular, Jenkins and van Kerm (2006) show that when inequality is measured using one of the broad class of S-Gini indices (Yitzhaki, 1983), the change in inequality between two periods can be decomposed into two factors; one that captures the reranking mobility, and one that quantifies vertical mobility – that is whether it favoured the rich or the poor. These two measures correspond respectively to concepts of mobility as positional change and individual income growth.

This type of inequality change decomposition is similar to approaches used for poverty trends decompositions in development economics (Datt and Ravallion (1992), Kakwani (1993, 2000), Tsui (1996), or more recently Ravallion and Chen (2003)). However, these older approaches track the fortunes of incomes groups rather than individuals, taking no account of changes in the composition of the poor group over time. The approach of Jenkin and van Kerm follows the income paths of individuals instead of income groups, which requires knowledge of the initial and final distributions of income, as well as of the transition process linking observations on these two distributions.

The decomposition can be performed on any of the class of Gini indices where different weighting can be given to inequality at different points of the income distribution (Yitzhaki, 1983). The analysis here follows the most common approach of using the standard Gini coefficient.

The change in inequality between two periods, measured using the Gini coefficients of initial and final periods can be decomposed as follows:

$$\Delta G = G_f - G_s = (G_f - CI_{fs}) + (CI_{fs} - G_s) = \left(\frac{2}{\bar{y}_f}\operatorname{cov}(y_f, R_f) - \frac{2}{\bar{y}_f}\operatorname{cov}(y_f, R_s) \right) + \left(\frac{2}{\bar{y}_f}\operatorname{cov}(y_f, R_s) - \frac{2}{\bar{y}_s}\operatorname{cov}(y_s, R_s) \right) = M^R - M^H \tag{6.3}$$

G_f and G_s are the Gini coefficients of final and initial incomes respectively, CI_{fs} is the concentration index from incomes in the final period f ranked by period s incomes, M^H is the vertical mobility index and M^R is the horizontal mobility index.

The vertical mobility index M^H captures the effects of changes in incomes on relative inequality. It is determined by the scale of income changes q and their progressivity P.

$$M^H = \left(\frac{2}{\bar{y}_s} \operatorname{cov}(y_s, R_s) - \frac{2}{\overline{\Delta y_f}} \operatorname{cov}(\Delta y_f, R_s) \right) \left(\frac{\overline{\Delta y_f}}{\bar{y}_f} \right)$$
$$= (G_s - CI_{\Delta y,s}) \left(\frac{\overline{\Delta y_f}}{\bar{y}_f} \right) \tag{6.4}$$

$CI_{\Delta y,s}$ is the concentration coefficient of income changes ranked by income in the initial period s; $\overline{\Delta y_f} = \bar{y}_f - \bar{y}_s$ is the average income change between s and f. M^H is positive if income changes are equalising, meaning they reduce inequality *ceteris paribus*. Accordingly, it will be negative if income changes are disequalizing, resulting in an increase in inequality. It will be zero if relative income changes are independent of income.

Progressivity is captured by the Kakwani-type (1977) index $P = (G_s - CI_{\Delta y,s})$. P is positive if income changes are more concentrated among the poorer individuals, meaning these individuals either obtain a bigger share of total net income gains, or alternatively suffer a bigger share of total net income losses compared to their initial share of income attainment. P is negative if the richer individuals obtain a bigger share of income gains or suffer a bigger share of income losses. In this manner, positive values of P mean equalizing effect for net income improvements and disequalizing effect for net income losses. Given any P, the overall impact of vertical mobility on inequality will be proportional to the scale of income changes $q = \overline{\Delta y_f} / \bar{y}_f$.

M^R captures the effect of the reshuffling of individuals within the income distribution. It must be zero or positive, exacerbating inequality, since those who go up the income ladder must be better off in the final period than those who move down.

Smaller inequality in final incomes happens only if income growth is progressive and it does not result in a reranking of individuals large enough to more than offset the equalizing impact of progressivity.

Since $\Delta G = M^R - M^H$ is an accounting identity, the three elements cannot have distinct and independent welfare implications. For a given level of progressivity in income changes, M^H, a higher reranking mobility M^R will lead to a lower level of reduction in inequality. For a given change in inequality, a higher reranking will be associated with a higher degree of vertical mobility. If reranking is held fixed, more pro-poor growth will mean larger reduction in inequality.

When inequality change is measured using a relative inequality measure like the Gini coefficient, the result of vertical mobility will be informative about the validity of Gibrat's law (1931) of proportionate effect, which states that the rate of growth of an enterprise is unrelated to its size and therefore determined by random facts. The violation of this empirical law would mean that smaller farms grow at a faster rate than larger ones (which would be shown by progressivity of income growth), or vice versa (shown by regressivity of income growth). Neutral income growth (neither progressive nor regressive) would validate Gibrat's Law.

6.3.4 Decomposition of vertical mobility

This is an extension to the inequality change decomposition in the manner of Allanson and Petrie (Allanson and Petrie, 2013) who use the regression-based decomposition to analyse the determinants of vertical mobility. Allanson and Petrie have used this methodology to analyse income-related health inequality, and this is the first time it is used outside of this context.

The use of regression-based decomposition approach allows the vertical mobility index to be decomposed into its determinants. The question that the vertical mobility index addresses is whether relative income changes favour those who are initially poor or those who are initially rich. Nevertheless, this index provides a misleading measure of how much relative income changes are linked to initial income, since initial income is not the only thing that affects these changes. Factors that impact income growth and are correlated with initial income also play a part; these factors will be the determinants of income changes from the ECM model, for example the changes in the economic size of farms. This implies there is a need for a procedure that can determine the contributions of inequalities in all the determinants of income changes to the overall vertical mobility.

Borrowing from the approach of Allanson and Petrie (2013), this can be achieved with the use of a model capturing the determinants of individual income changes (see chapter 5, the technical presentation of the model is repeated here to describe the decomposition approach). If we assume that a stable dynamic income function exists over time, we can specify a first-order ADLM, with lagged and contemporaneous responses to changes in income determinants:

$$y_{t+1} = \alpha_0 + \sum_{k=1}^{K} \delta_k x_{k,t+1} + \sum_{k=1}^{K} \alpha_k x_{kt} + (1-\lambda) y_t + \upsilon_{t+1} \quad ; t=1, \ \dots \ T\text{-}1 \qquad (6.5)$$

where the composite error consists of fixed effects and idiosyncratic error terms, $\upsilon_{i,t+1} = \alpha_i + \varepsilon_{i,t+1}$.

This can easily be expressed as an Error Correction Model:

$$\Delta y_{t+1} = \left(y_{t+1} - y_t\right) = \sum_{k=1}^{K} \delta_k \left(x_{k,t+1} - x_{kt}\right) + \lambda\left(\left(\beta_0 + \sum_{k=1}^{K} \beta_k x_{kt}\right) - y_t\right) + \upsilon_{t+1}$$
$$= \sum_{k=1}^{K} \delta_k \Delta x_{t+1}^{k} + \lambda\left(y_t^* - y_t\right) + \upsilon_{t+1}; \tag{6.6}$$

$\beta_0 = \alpha_0 / \lambda$ and $\beta_k = \left(\alpha_k + \delta_k\right) / \lambda$ can be interpreted as parameters of the long-run income relationship

$$y_t^* = \beta_0 + \sum_{k=1}^{K} \beta_k x_{kt} \tag{6.7}$$

where $\left(y_t^* - y_t\right)$ corresponds to the 'equilibrium error' in the current period and $\lambda\left(0 \le \lambda \le 1\right)$ is the rate of adjustment towards equilibrium. If $\lambda = 1$, and α_k 's (k=1,…K) are zeros, there is full adjustment and the equation collapses to a static model with $y_t = y_t^* + \upsilon_t$ in all periods.

With $1 \le s < f \le T$ and f=s+1, vertical mobility index M^H can be decomposed in the following way:[42]

$$M^H = Pq = \left\{ \sum_{k=1}^{K} \left(G_s - CI_{ss}^{\Delta x_k}\right) \frac{\hat{\delta}_k \overline{\Delta x_{kf}}}{\overline{\Delta y_f}} + \left(G_s - CI_{ss}^{\hat{\alpha}_0}\right) \frac{\hat{\alpha}_0}{\overline{\Delta y_f}} + \right.$$
$$\left. \sum_{k=1}^{K} \left(G_s - CI_{ss}^{x_k}\right) \frac{\hat{\lambda}\hat{\beta}_k \overline{x}_{ks}}{\overline{\Delta y_f}} - \left(G_s - G_s\right) \frac{\hat{\lambda}_k \overline{y}_s}{\overline{\Delta y_f}} + \left(G_s - CI_{ss}^{\hat{\varepsilon}}\right) \frac{\bar{\hat{\varepsilon}}}{\overline{\Delta y_f}} \right\} \left(\frac{\overline{\Delta y_f}}{\overline{y_f}}\right) \tag{6.8}$$

with $\hat{\alpha}_0 = \hat{\lambda}\hat{\beta}_0$, $\hat{\delta}_k$'s, $\hat{\lambda}$, $\hat{\beta}_k$'s and $\hat{\beta}_0$ being the estimates of the parameters from the dynamic income model. $CI_{ss}^{\Delta x_k}$ is a concentration index of changes in income

[42] $\sum_{k=1}^{K} \hat{\delta}_k \frac{\overline{\Delta x_{kf}}}{\overline{\Delta y_f}} + \hat{\alpha}_0 \frac{1}{\overline{\Delta y_f}} + \sum_{k=1}^{K} \hat{\lambda}\hat{\beta}_k \frac{\overline{x}_{ks}}{\overline{\Delta y_f}} - \hat{\lambda}\frac{\overline{y}_s}{\overline{\Delta y_f}} = 1$ by definition, because the mean of the regression residuals $\hat{\varepsilon}_f$ will equal zero by construction.

determinant k ranked by period s income, $CI_{ss}^{x_k}$ is the concentration index of income determinant k ranked by period s income, etc. The equation can be rewritten as:

$$\begin{aligned} M^H &= \left\{ \sum_{k=1}^{K} \left(G_s - CI_{ss}^{\Delta x_k} \right) \frac{\hat{\delta}_k \overline{\Delta x_{kf}}}{\bar{y}_f} + \left(G_s - C_{ss}^{\hat{\alpha}_0} \right) \frac{\hat{\alpha}_0}{\bar{y}_f} \right. \\ &\left. + \sum_{k=1}^{K} \left(G_s - CI_{ss}^{x_k} \right) \frac{\hat{\lambda}\hat{\beta}_k \bar{x}_{ks}}{\bar{y}_f} + (G_s - CI_{ss}^{\hat{\varepsilon}}) \frac{\bar{\hat{\varepsilon}}}{\bar{y}_f} \right\} \\ &= \sum_{k=1}^{K} P_{\Delta x_k} q_{\Delta x_k} + P_{\hat{\alpha}_0} q_{\hat{\alpha}_0} + \sum_{k=1}^{K} P_{x_k} q_{x_k} + (G_s - CI_{ss}^{\hat{\varepsilon}}) \frac{\bar{\hat{\varepsilon}}}{\bar{y}_f} \end{aligned} \tag{6.9}$$

Which, by combining the contribution from the constant and the long-run equilibrium parameters, can be also rewritten as:

$$\begin{aligned} M^H &= \left\{ \sum_{k=1}^{K} \left(G_s - CI_{ss}^{\Delta x_k} \right) \frac{\hat{\delta}_k \overline{\Delta x_{kf}}}{\bar{y}_f} + \left(G_s - CI_{ss}^{(\hat{y}_s^* - y_s)} \right) \frac{\hat{\lambda}\overline{(\hat{y}_s^* - y_s)}}{\bar{y}_f} + (G_s - CI_{ss}^{\hat{\varepsilon}}) \frac{\bar{\hat{\varepsilon}}}{\bar{y}_f} \right\} \\ &= \sum_{k=1}^{K} P_{\Delta x_k} q_{\Delta x_k} + P_{(\hat{y}_s^* - y_s)} q_{(y_s^* - y_s)} + (G_s - CI_{ss}^{\hat{\varepsilon}}) \frac{\bar{\hat{\varepsilon}}}{\bar{y}_f} \end{aligned} \tag{6.10}$$

where M^H consists of the contributions from the changes in individual income change determinants within the dynamic income model, the contribution of the disequilibrium error and a final term due to the regression residual, reflecting the unpredictability of future income outcomes[43]. The impact of each determinant can be expressed as a product of the progressivity and scale of income changes due to that determinant. If an income determinant has a positive scale factor, meaning that its contribution to the overall income change is positive, it will also have a positive impact on M^H if it is distributed less unequally than starting income, when it is ordered by starting income. Accordingly, an income determinant with a negative scale factor will have a negative

[43] There is no separate term in initial income y_s since $P_y = \left(G_{ss} - G_{ss} \right) = 0$ by definition. Thus the sum of the scale factors, $\sum_{k=1}^{K} q_{\Delta x_k} + q_{\hat{\alpha}_0} + \sum_{k=1}^{K} q_{x_k} = q - q_y$ not q, where $q_y = -\hat{\lambda}\,\bar{y}_s / \bar{y}_f$.

impact on M^H if it is distributed less unequally than starting income when ordered by starting income, and will have a positive impact on M^H otherwise.

The sign of the contribution of adjustment towards the equilibrium level of income as implied by $P_{(\hat{y}_s^*-y_s)}$ and $q_{(\hat{y}_s^*-y_s)}$ will be determined by the relationship between the actual and equilibrium income inequalities. The equation below helps to understand this point:

$$P_{(\hat{y}_s^*-y_s)}q_{(\hat{y}_s^*-y_s)} = \left(G_s - CI_{ss}^{(\hat{y}_s^*-y_s)}\right)\frac{\hat{\lambda}\overline{(\hat{y}_s^*-y_s)}}{\bar{y}_f} = \left(G_s - G_{\hat{y}_s^*}\right)\frac{\hat{\lambda}\overline{\hat{y}_s^*}}{\bar{y}_f} \tag{6.11}$$

where $\frac{\hat{\lambda}\overline{\hat{y}_s^*}}{\bar{y}_f}$ will always be positive, therefore the overall contribution of $P_{(\hat{y}_s^*-y_s)}q_{(\hat{y}_s^*-y_s)}$ to M^H will be determined by the sign of $\left(G_s - G_{\hat{y}_s^*}\right)$. If actual inequality is bigger than the inequality of equilibrium incomes, the contribution from equilibrium adjustment will be equalizing; conversely, if the actual inequality is smaller, this adjustment will act in a disequalizing manner.

6.3.5 Multiyear decomposition extension

One might want to decompose the change in inequality over a longer time horizon than two consecutive years. This extension is a new addition to the methodology of Allanson and Petrie (2013). While the overall change in inequality for a multiyear period will be equal to the sum of changes between the consecutive years in this period, such additivity does not apply to vertical mobility and reranking indices. That is the sum of either vertical or reranking mobility for individual year changes will not be equal to the corresponding mobility measures over the multiyear change. Taking an example of two years period:

$$\Delta G_{t,t+2} = G_{t+2} - G_t = \Delta G_{t,t+1} + \Delta G_{t+1,t+2} = \\ (M^R_{t,t+1} - M^H_{t,t+1}) + (M^R_{t,t+2} - M^H_{t,t+2}) = M^R_{t,t+2} - M^H_{t,t+2} \tag{6.12}$$

where $\Delta G_{t,t+2}$ is the change in Gini coefficients between periods t+2 and t, G_{t+2} is the Gini coefficient in period t+2, $M^R_{t,t+1}$ is the vertical mobility between periods t and t+1, and $M^H_{t,t+1}$ is the reranking mobility between periods t and t+1, etc.

However, $M^R_{t,t+1} + M^R_{t+1,t+2} \neq M^R_{t,t+2}$ and $M^H_{t,t+1} + M^H_{t+1,t+2} \neq M^H_{t,t+2}$ which is caused by the changes in ranking that occur in between[44]. This means that measuring vertical mobility over a multiyear period cannot be achieved by simply adding the indices of individual changes in between, and consequently, a modified approach to decomposition is required.

In general, the multiyear income change from period t to $t+m$ (m>1) can be written from (6.6) as:

$$y_{t+m} - y_t = \sum_{k=1}^{K}(\sum_{j=1}^{m}(1-\lambda)^{m-j}\delta_k \Delta x_{k,t+j}) + \sum_{k=1}^{K}(\sum_{j=1}^{m-1}\sum_{i=0}^{m-j}(1-\lambda)^i \lambda \beta_k \Delta x_{k,t+j}) \\ +(\sum_{j=1}^{m}(1-\lambda)^{m-j})\lambda(y_t^* - y_t) + \sum_{j=1}^{m}(1-\lambda)^{m-j}\varepsilon_{t+j} \tag{6.13}$$

[44] As Ruiz-Castillo (2004) points out for the case of two periods, the rank reversal in first and second period is separate to rank reversal in first period and aggregate income over both periods.

Taking the parameters from this multiyear change obtained using the model estimates, vertical mobility for a multiyear period will decompose in the following way:

$$M^H = \sum_{k=1}^{K}\left(G_s - CI_{ss}^{\Phi}\right)\frac{\Phi}{\overline{y}_f} + (G_s - CI_{ss}^{\hat{y}_s^* - y_s})\frac{(\sum_{j=1}^{m}(1-\lambda)^{m-j}\lambda(\overline{\hat{y}_s^* - y_s})}{\overline{y}_f} +$$
$$(G_s - CI_{ss}^{(1-\lambda)^{m-j}\hat{\varepsilon}_{t+j}})\frac{\sum_{j=l}^{m}(1-\lambda)^{m-j}\overline{\hat{\varepsilon}}_{t+j}}{\overline{y}_f} \qquad (6.14)$$
$$= \sum_{k=1}^{K} P_{combined\Delta x}q_{combined\Delta x} + P_{\left(\hat{y}_s^* - y_s\right)}q_{\left(\hat{y}_s^* - y_s\right)} + P_{combined\hat{\varepsilon}}q_{combined\hat{\varepsilon}}$$

where $\Phi = \sum_{j=1}^{m}(1-\hat{\lambda})^{m-j}\hat{\delta}_k\overline{\Delta x}_{t+j,kf} + \sum_{j=1}^{m-1}(\sum_{i=0}^{m-j}(1-\hat{\lambda})^i)\hat{\lambda}\hat{\beta}_k\overline{\Delta x}_{t+j,kf}$. Therefore the vertical mobility in a multiyear period will consist of the term which captures the combined effect of changes in income determinants, the combined disequilibrium error in the period, and the combined share of mobility due to regression residual which reflects the unpredictability of income. When *m*=1, this equation simplifies to (6.10).

6.3.6 Analysis of structural income inequality

The coefficients from the long-run income relationships in the income model (chapter 5) can be used to obtain the equilibrium income levels. The Gini coefficient of that income, $G_{\hat{y}_t*}$, will provide a measure of the long-run, or chronic, inequality. The difference between the actual income inequality and structural income inequality in a given year provides a proxy for income risk, which corresponds to the mobility concept of income risk identified by Jantti and Jenkins (2013).

Further, using a regression-based decomposition of the Gini coefficient (Shorrocks, 1983; Morduch and Sicular, 2002), the equilibrium Gini coefficient is decomposed with the use of long-term coefficients from the income model in order to provide information on the determinants of structural inequality:

$$G_{\hat{y}_t*} = \sum_{k=1}^{K} \hat{\beta}_k \frac{2}{\bar{\hat{y}}_t^*} Cov(x_{kt}, R_{\hat{y}*_t}) = \sum_{k=1}^{K} \frac{\hat{\beta}_k \bar{x}_{kt}}{\bar{\hat{y}}_t^*} CI_{\hat{y}_t*}^{x_k} \tag{6.15}$$

where $\hat{\beta}_k$ is the estimate of the long-run coefficient for income determinant *k*, $\bar{\hat{y}}_t^*$ is the mean value of equilibrium income in period *t*, $\bar{x}_{kt}$ is the mean value of income determinant *k* in period *t*, and $CI_{\hat{y}_t*}^{x_k}$ is the concentration index of determinant *k* ranked by equilibrium income in period *t*.

Hence the Gini coefficient can be represented as a weighted sum of the concentration indices of income determinants, where the weights correspond to the shares of income attributable to each determinant.

6.4 Empirical section

This chapter uses weighted farm-level FAS data for the years 1996-2010, which corresponds to 1995/96-2009/10 production years. The description of the variables and their summary statistics correspond to those reported in section 5.4.1, as both chapters work with the same dataset. However, the calculation of indices here will limit the sample to balanced panels for the period under consideration, that is either annual changes or multiyear changes.

The empirical results start with a descriptive summary on income and Gini coefficients trends and a discussion of Shorrocks rigidity index results. This is followed by the results from annual and multiyear decompositions of inequality changes following the Jenkins and van Kerm (2006) approach; a robustness check of these results is also provided. Moving on, the vertical mobility of annual changes is decomposed using Allanson and Petrie's (2013) method, followed by the decomposition of vertical mobility for multiyear periods. Lastly, the equilibrium inequality and its determinants are discussed.

6.4.1 Descriptive summary

Table 6.1 provides information on mean level of income and the Gini coefficient in each year. Figures 6.1 and 6.2 graphically show the trends in average income over the studied period 1996-2010; Figure 6.1 plots the mean income for every year, and Figure 6.2 shows the average income change[45].

Table 6.1 Average income and Gini coefficient values, 1996-2010.

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Average income	39096	44144	27955	29965	26842	27719	31131	32660	37498	35877	32302	37130	52203	48785	49544
Gini coefficient	0.48	0.44	0.52	0.52	0.57	0.54	0.52	0.47	0.46	0.49	0.49	0.53	0.52	0.52	0.52

The trends of initial decline and then slow recovery over years in average farm income can be better understood with some knowledge about contemporaneous events in the agricultural sector included in the Scottish Government's annual economic reports on agriculture (SEERAD, 2001-2007; SGRERAD, 2008-2012). And so, the decrease in incomes between 1996/97 to 1998/1999 was mainly driven by a strong pound, weak world commodity prices and the ongoing impact of Bovine spongiform encephalopathy (BSE, commonly known as mad cow disease). In 2000/2001 a decline in output and income values continued due to several factors, most notably the weak Euro, FMD outbreak and autumn floods.

Following this, the average income increased in 2001/2002 and 2002/2003 as agricultural prices improved, particularly the ones for all types of potatoes and milk, and output value for livestock recovered following the FMD disease outbreak. This continued in 2003/2004 when the cereal sector benefited from a good summer and experienced improved yields.

In 2004/2005 and 2005/2006 net incomes were lower again across most sectors due to a combination of higher input costs and lower output prices. Bad weather conditions did

[45] Where the change in income is calculated for balanced set of farms present in two consecutive years and corresponds to values in Table 6.3 later on.

not affect yield as much, but the quality, and consequently the crop prices suffered.

Figure 6.1 Mean income (£) trends

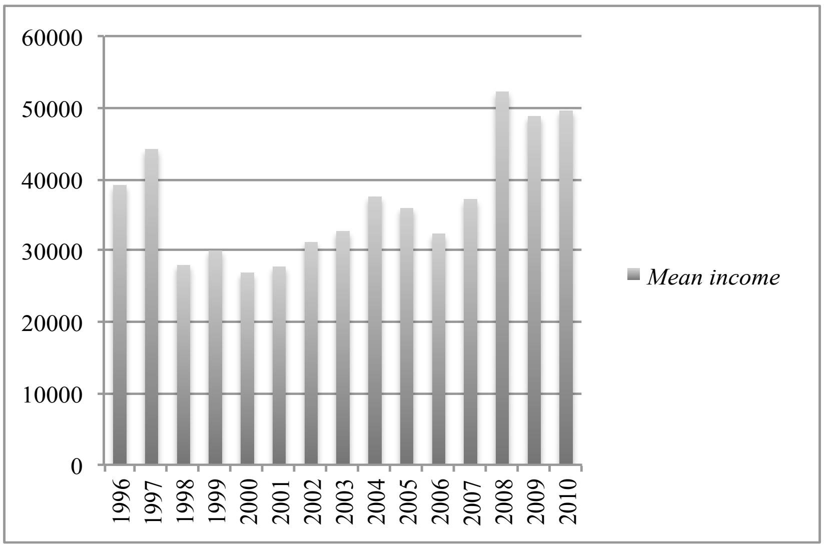
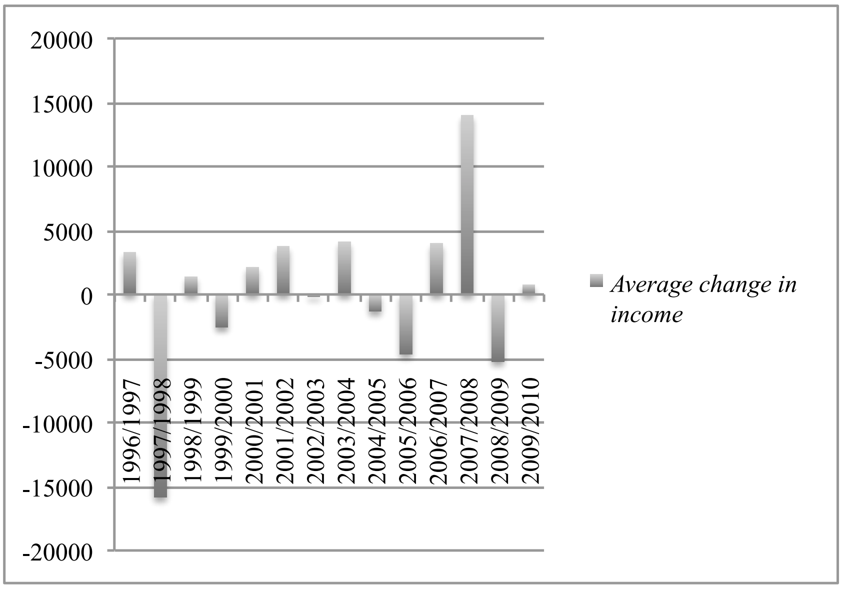


Figure 6.2 Average change in income (£) trends



The following increase in average income was caused by an increase in incomes for General Cropping, Cereal and Dairy farms, reflecting the increase in prices for milk and crops, driven by the global demand for cereals outstripping the global supply. The recession in 2008/2009 caused the prices to fall, and the two largest harvests in a row meant that stocks recovered, which has been accompanied by key inputs being at historically high prices, and is reflected in slight drop in average income in 2009. In 2010 income levels increase again reflecting increasing prices for most commodities.

The above description illustrates how various events in the agricultural markets affect the income levels from farming. Both the magnitude and the direction of average income changes are very variable, going from -15858 in 1997 to 14005 in 2007. The standard deviation for average income across the years was 8367; this means relatively high variability between years, indicating high instability of agricultural incomes. As the OECD points out:

> "Agricultural activity is subject to different risks, some natural or biological in origin, others economic. These risks affect production volumes and prices and are thought to result in receipts and incomes that are more variable than in many other sectors. […] At the individual level, excessive farm income variability can be a problem, in particular for farms that have not been able to adopt basic income risk strategies and, as a result, are too dependent on one source of income or do not have sufficient savings or capital raising capacity".
>
> (OECD, 2003, p. 20)

A wide range of studies looks at the issues of income variability (Hegrenes *et al*., 2001; Hill, 1999; Mishra and Goodwin, 1997; Cordts *et al.*, 1984). Vrolijk *et al*. (2009) provide an extensive study of farm income volatility in the EU using FADN data for years 1990-2003. The study finds substantial volatility in farm incomes caused mainly by factors like instability of agricultural markets, animal diseases and weather conditions. The authors further conclude that volatility in some sectors is larger than in others; one reason behind this is differences in CAP measures for different commodities, for example dairy farmers had more stable incomes than pig farmers since CAP stabilizes milk and dairy prices while pig prices are not managed to avoid fluctuations. Another reason is dependency on specific inputs, like energy in horticulture greenhouses or compound feeds for speciality pigs and poultry farms; price fluctuations in these inputs will impact the income volatility for the specific farm types. Lastly, differences in *margin of income*[46] also count. The more specialised larger farms that hire more labour have smaller profit margins and larger volatility; such large farms are more characteristic of certain commodity types, like horticulture or pigs and poultry farms.

The Gini coefficient fluctuates over the years, staying in the range of 0.45 - 0.57. This indicates that the level of relative inequality in Scottish agricultural incomes is higher than overall income inequality in Scotland, for which the value of the Gini coefficients in the corresponding period fluctuated between 0.30 – 0.35 (Scottish Government, 2013a)[47].

What is often ignored in analysis of ordinary Gini indices in a dynamic setting is the link between the value of the Gini coefficient and the average income in a given year, since Gini coefficient is normalized by mean income. This means that a change in

[46] What the authors define as "the returns of products less the costs paid (and including depreciation) as a percentage of the returns" (Vrolijk *et al*., 2009, p. 10).
[47] However, it needs to be noted that these figures are not directly comparable, since the measure of income used in this study represents profitability from farming rather than overall income available to farmers (which might also include income from non-agricultural sources). It is the overall income available to farmers that is used as a representative figure in generating the Gini coefficient for all incomes in Scotland.

relative inequality can occur either due to a change in the absolute dispersion of incomes or due to a change in average income.

Figure 6.3 Trends in average income and inequality.

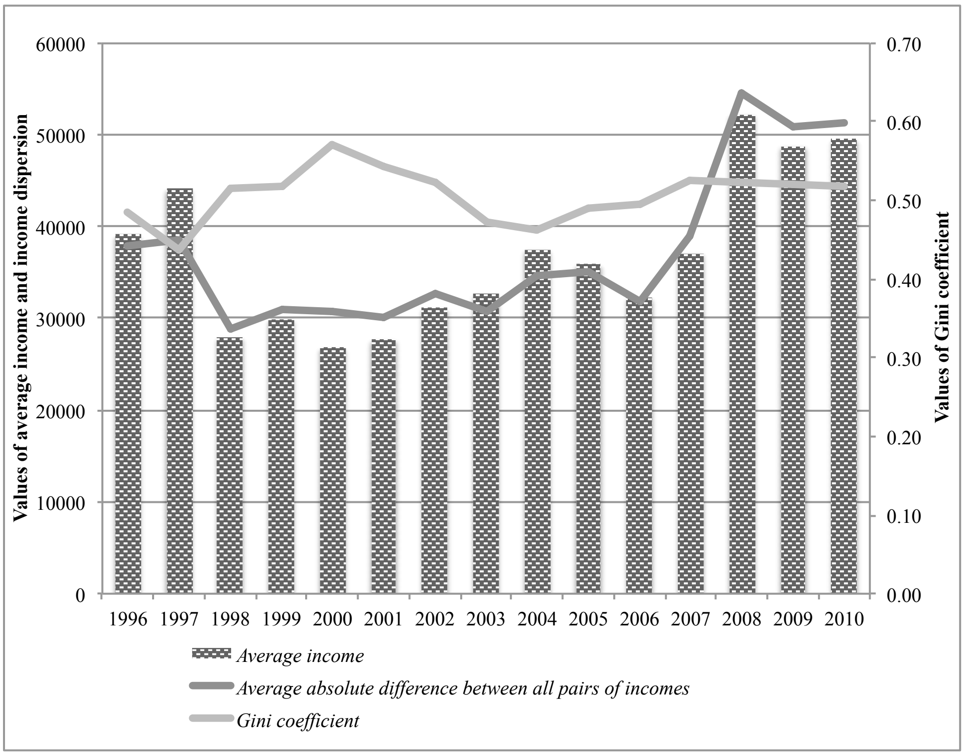


Figure 6.3 shows the values of the Gini coefficients, the average incomes and the average absolute dispersion of incomes[48]. As can be seen, the dispersion of incomes and mean value of income generally move in the same directions across the years, which means that common shocks are broadly proportional in nature[49]; this supports the use of slope dummies in the income model in chapter 5, since they control for proportional impact of time fixed effects.

[48] Where the average absolute difference is calculated as Gini coefficient times twice the average income (Charles-Coll, J. A., 2011).
[49] If shocks were not proportional in nature, then an increase in mean income would not be reflected in an increase in income dispersion; this would be the case if for example a good year implied that everyone's income goes up by 1000 pounds – mean income would increase but the dispersion would not change.

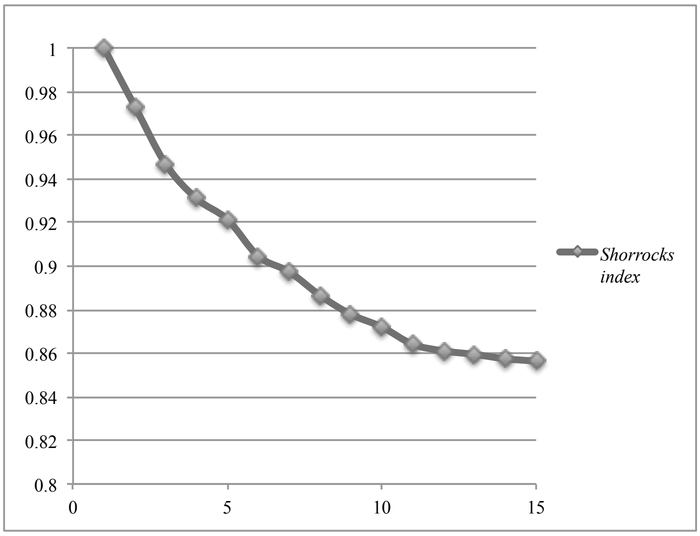
6.4.2 Shorrocks rigidity measure

Shorrocks' rigidity index was calculated using incomes in the years 1996-2010, which gives a maximum *T* of fifteen years[50]. Numerical results are presented in Table 6.2, while Figure 6.3 plots the evolution of the index as the measurement period is extended.

Table 6.2 Shorrocks rigidity index, T=1,...,15.

Measurement period	*T*	*Weighted average of annual Gini coefficients*	*Gini coefficient for T-period averaged income*	*Shorrock's R index*
1996	1	0,46	0,46	1,000
1996-1997	2	0,42	0,41	0,973
1996-1998	3	0,43	0,40	0,947
1996-1999	4	0,43	0,40	0,931
1996-2000	5	0,43	0,40	0,921
1996-2001	6	0,44	0,39	0,905
1996-2002	7	0,44	0,39	0,897
1996-2003	8	0,43	0,39	0,887
1996-2004	9	0,43	0,38	0,878
1996-2005	10	0,43	0,37	0,872
1996-2006	11	0,43	0,37	0,864
1996-2007	12	0,44	0,37	0,861
1996-2008	13	0,44	0,38	0,859
1996-2009	14	0,45	0,38	0,857
1996-2010	15	0,45	0,38	0,856

Figure 6.4 Shorrocks rigidity index, T=1,...15.



[50] This is performed on a balanced panel of 151 farms.

As Table 6.2 shows, Shorrocks rigidity index is equal to 1 when T=1, which is true by definition. With T>1, $G_{\bar{y}}$ is consistently smaller than the weighted average of Gini coefficients for the measurement period, and this discrepancy increases as the measurement period is extended. Over one year change in incomes (T=2), Shorrocks index is equal 0.97; this decreases to 0.90 with T=6, but then the decrease slows down. With T=11, the value of the index goes down to approximately 0.86 and it does not change as the measurement period is extended further all the way to T=15.

This result implies that 86% of cross-sectional inequality is persistent, and the remainder is due to transitory shocks. In other words, there is some degree of transitory inequality, such that annual Gini coefficients tend to overstate the extent of inequality in longer-term average incomes, but the overwhelming bulk of cross-sectional inequality is structural in nature. This is in line with findings of Phimister *et al*. (2004) who found that averaging incomes over two years induced a 10% drop in the inequality levels in Scottish agricultural incomes measured by the Gini coefficient.

6.4.3 Inequality change decomposition

In this subsection the inequality change is decomposed into vertical and reranking mobility. The measures of vertical and reranking mobility presented here correspond to two of the mobility concepts distinguished by Jantti and Jenkins (2013), that is mobility as individual income growth and mobility as positional change, respectively. In this context mobility as income growth is desirable when growth is progressive as it reduces inequality, whereas positional movement is always disequalizing.

If the dynamic income process obeys Gibrat's Law, then the expected income growth should be distributionally neutral in relative terms, meaning it is neither progressive (which would favour poorer farms), nor regressive (which would favour richer farms).

This section will start with the results of annual inequality changes decomposition, followed by multiyear changes decompositions and finished with a robustness check of the results concerning the nature of the individual income growth.

6.4.3.1 Annual changes

Table 6.3 provides statistical summary of the initial and final incomes for each year, including (ordinary) Gini coefficients; it also presents the results of the change inequality decomposition into vertical and horizontal components from equation (6.3) and (6.4) in the methodology section. In all tables, the figures in bold are the results and the small print figures are bootstrap errors based on 1000 repetitions[51].

The summary indices are presented for income changes between two consecutive years, thus like in chapter 5, term *initial income* refers to the income in year *t*, and *final income* is the income in *t*+1. The analysis is done on pairs of adjacent years using observations on farms that are present in dataset for both years, while the panel is not balanced throughout the year. As a result the mean of final income in one year does not correspond to the mean of initial income in the following year, since the sample sizes used in both cases are different[52].

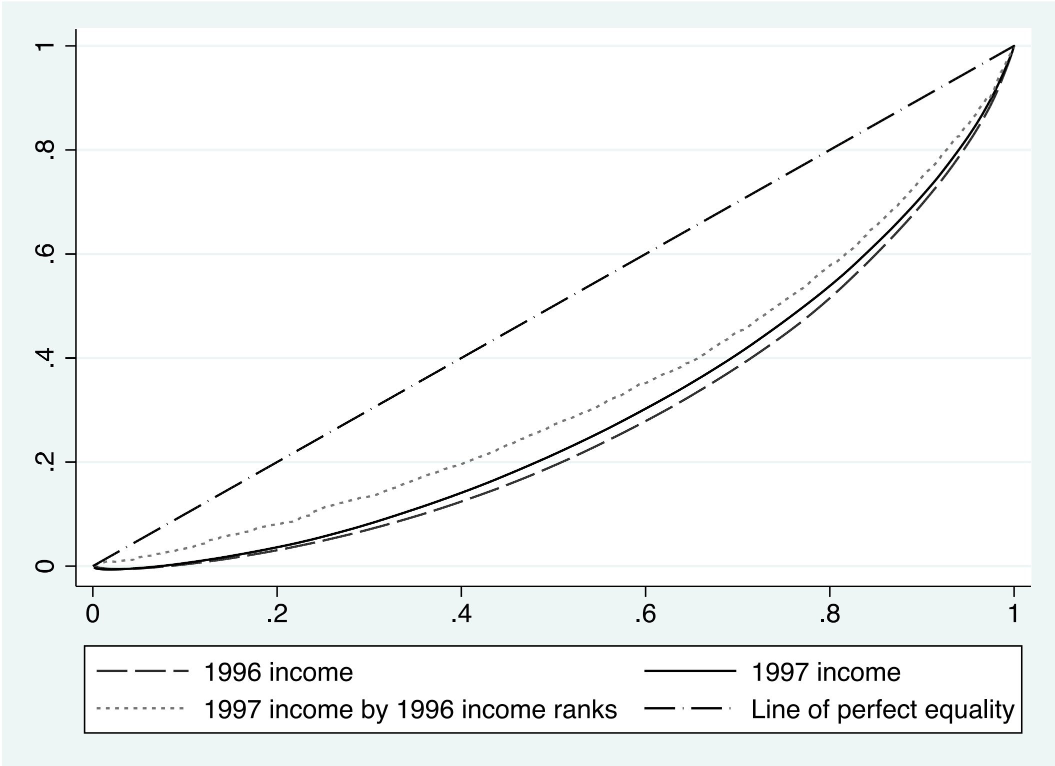
[51] Statistical significance at 1%, 5% and 10% are denoted respectively as ***, **, *.
[52] The sample size for each pair of years corresponds to that given in Table 5.1.

Table 6.3 Summary indices, annual change decompositions.

	Mean initial income	*Gini coefficient of initial income*	*Mean final income*	*Gini coefficient of final income*	*CI of final income ranked by initial income*	*Redis-tributive index*	*Vertical mobility index*	*Prog-ressivity index*	*Scale of income change*	*Reranking mobility index*	*Average change in income*
1996	**39096** ***	**0,48** ***	**42392** ***	**0,45** ***	**0,36** ***	**-0,03** **	**0,12** ***	**1,58**	**0,08** *	**0,09** ***	**3296** **
/1997	*1505*	*0,02*	*1474*	*0,02*	*0,02*	*0,02*	*0,02*	*9,67*	*0,03*	*0,02*	*1334*
1997	**44144** ***	**0,44** ***	**28286** ***	**0,50** ***	**0,41** ***	**0,06** ***	**0,03** *	**-0,05** *	**-0,56** ***	**0,09** ***	**-15858** ***
/1998	*1338*	*0,01*	*988*	*0,02*	*0,02*	*0,02*	*0,02*	*0,03*	*0,04*	*0,01*	*1024*
1998	**27955** ***	**0,52** ***	**29343** ***	**0,52** ***	**0,41** ***	**0,01**	**0,10** ***	**2,15**	**0,05**	**0,11** ***	**1388**
/1999	*1041*	*0,02*	*1447*	*0,03*	*0,03*	*0,02*	*0,03*	*55,21*	*0,04*	*0,02*	*1156*
1999	**29965** ***	**0,52** ***	**27387** ***	**0,56** ***	**0,46** ***	**0,05** **	**0,06** ***	**-0,59**	**-0,09** **	**0,10** ***	**-2577** ***
/2000	*1484*	*0,03*	*1465*	*0,03*	*0,03*	*0,02*	*0,02*	*1,06*	*0,04*	*0,01*	*965*
2000	**26842** ***	**0,57** ***	**28978** ***	**0,52** ***	**0,40** ***	**-0,05** *	**0,17** ***	**2,35**	**0,07** *	**0,13** ***	**2136** *
/2001	*1551*	*0,03*	*1654*	*0,02*	*0,03*	*0,03*	*0,03*	*23,28*	*0,04*	*0,02*	*1207*
2001	**27719** ***	**0,54** ***	**31467** ***	**0,52** ***	**0,37** ***	**-0,02**	**0,18** ***	**1,47**	**0,12** **	**0,15** ***	**3748** **
/2002	*1821*	*0,02*	*1298*	*0,02*	*0,02*	*0,03*	*0,03*	*6,49*	*0,05*	*0,02*	*1543*
2002	**31131** ***	**0,52** ***	**30999** ***	**0,49** ***	**0,33** ***	**-0,03**	**0,19** ***	**-44,79**	**0,00**	**0,16** ***	**-133**
/2003	*1374*	*0,02*	*1731*	*0,02*	*0,03*	*0,03*	*0,04*	*85,27*	*0,05*	*0,03*	*1587*
2003	**32660** ***	**0,47** ***	**36775** ***	**0,47** ***	**0,38** ***	**0,00**	**0,09** ***	**0,81**	**0,11** ***	**0,09** ***	**4115** ***
/2004	*1822*	*0,02*	*1670*	*0,02*	*0,02*	*0,02*	*0,02*	*0,68*	*0,03*	*0,01*	*1266*
2004	**37498** ***	**0,46** ***	**36167** ***	**0,49** ***	**0,38** ***	**0,03**	**0,09** ***	**-2,36**	**-0,04**	**0,12** ***	**-1332**
/2005	*1631*	*0,02*	*1809*	*0,02*	*0,03*	*0,02*	*0,02*	*1151,67*	*0,04*	*0,02*	*1280*
2005	**35877** ***	**0,49** ***	**31209** ***	**0,51** ***	**0,37** ***	**0,02**	**0,12** ***	**-0,77** *	**-0,15** **	**0,13** ***	**-4668** ***
/2006	*1715*	*0,02*	*1614*	*0,02*	*0,03*	*0,02*	*0,02*	*0,40*	*0,04*	*0,02*	*1165*
2006	**32302** ***	**0,49** ***	**36283** ***	**0,53** ***	**0,38** ***	**0,04**	**0,12** ***	**1,08**	**0,11** ***	**0,15** ***	**3980** ***
/2007	*1538*	*0,02*	*1705*	*0,02*	*0,03*	*0,02*	*0,03*	*2,00*	*0,04*	*0,02*	*1518*
2007	**37130** ***	**0,53** ***	**51134** ***	**0,52** ***	**0,39** ***	**0,00**	**0,13** ***	**0,49** ***	**0,27** ***	**0,13** ***	**14005** ***
/2008	*1870*	*0,02*	*2413*	*0,02*	*0,03*	*0,02*	*0,03*	*0,09*	*0,03*	*0,02*	*1683*
2008	**52203** ***	**0,52** ***	**46957** ***	**0,51** ***	**0,34** ***	**-0,01**	**0,18** ***	**-1,61**	**-0,11** **	**0,17** ***	**-5246** **
/2009	*2407*	*0,02*	*2266*	*0,02*	*0,03*	*0,02*	*0,03*	*10,49*	*0,05*	*0,02*	*2419*
2009	**48785** ***	**0,52** ***	**49544** ***	**0,52** ***	**0,36** ***	**0,00**	**0,16** ***	**10,66**	**0,02**	**0,16** ***	**759**
/2010	*2320*	*0,02*	*2439*	*0,02*	*0,03*	*0,02*	*0,03*	*89,74*	*0,04*	*0,02*	*2013*

In order to facilitate the understanding of how the elements of the inequality change decomposition come about, Figures 6.6 and 6.7 provide graphical representations of the measurement of inequality and corresponding decomposition for years when inequality is falling and rising respectively. Figure 6.6 shows the situation in 1996, where the inward shift for the 1997 income Lorenz curve represents a decrease in inequality (although the two curves overlap for the first fifth of the income ranks). The difference in the Gini coefficients that measures this change in inequality is given by twice the area between the 1996 and 1997 income Lorenz curves. This change can be broken down into two parts. One part is due to the difference between the 1996 income Lorenz curve and the concentration curve of 1997 incomes ranked by 1996 incomes, where the vertical redistributive effect of the income growth is given as twice the area between the

Figure 6.5 Decomposition curves, 1996.



two curves. In this case the concentration curve is unambiguously above the 1996 income Lorenz curve, so the growth is clearly pro-poor. If it was entirely below, it would be regressive. If the two curves crossed, it would not be clear from the graph whether the income growth is progressive or regressive (in such a case, the numerical result for this depends on which inequality measure from the class of the generalized Gini class of indices is used). The second part is due to the difference between the Lorenz curve for 1997 income and the concentration curve, which captures the extent of reranking (note that by construction the concentration curve will lie nowhere below the final income Lorenz curve so this is unambiguously disequalizing).

Figure 6.6 shows the curves for 1999 and represents a different relevant empirical case, opposite to that in 1996, that is when inequality increases; this is reflected in an outward shift of the Lorenz curve for 2000 income. The concentration curve still lies above the

1999 income Lorenz curve, which means that income changes were progressive, but they were more than offset by the impact of reranking - therefore the overall result was an increase in inequality.

Figure 6.6 Decomposition curves, 1999.

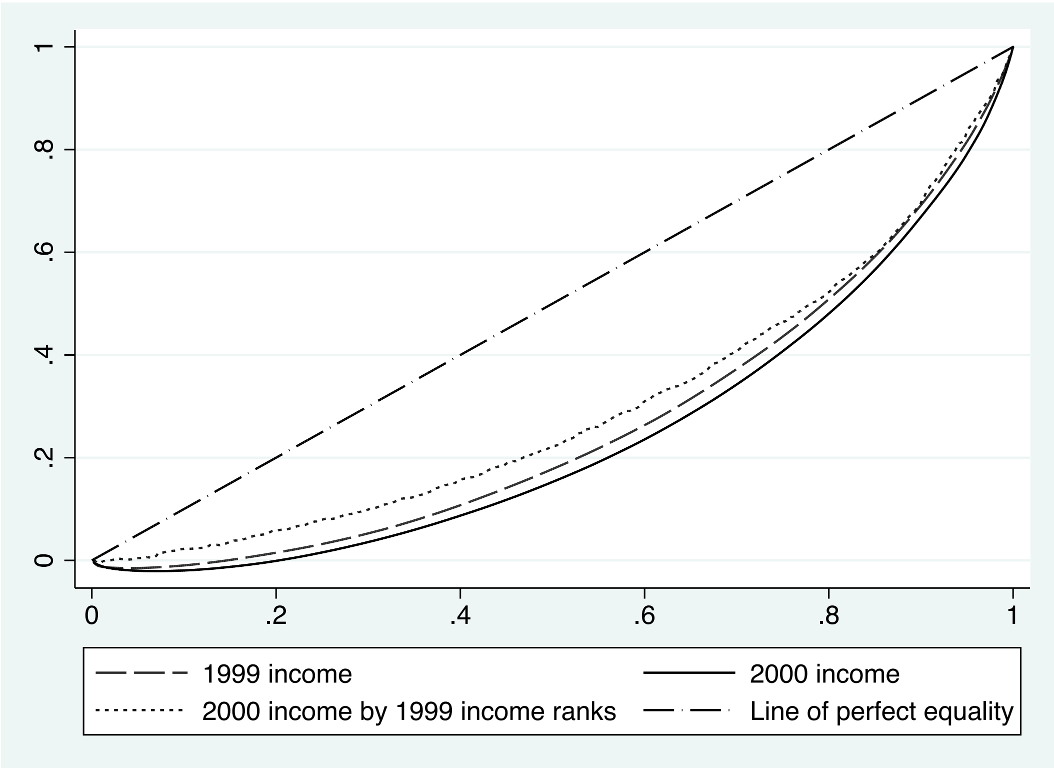
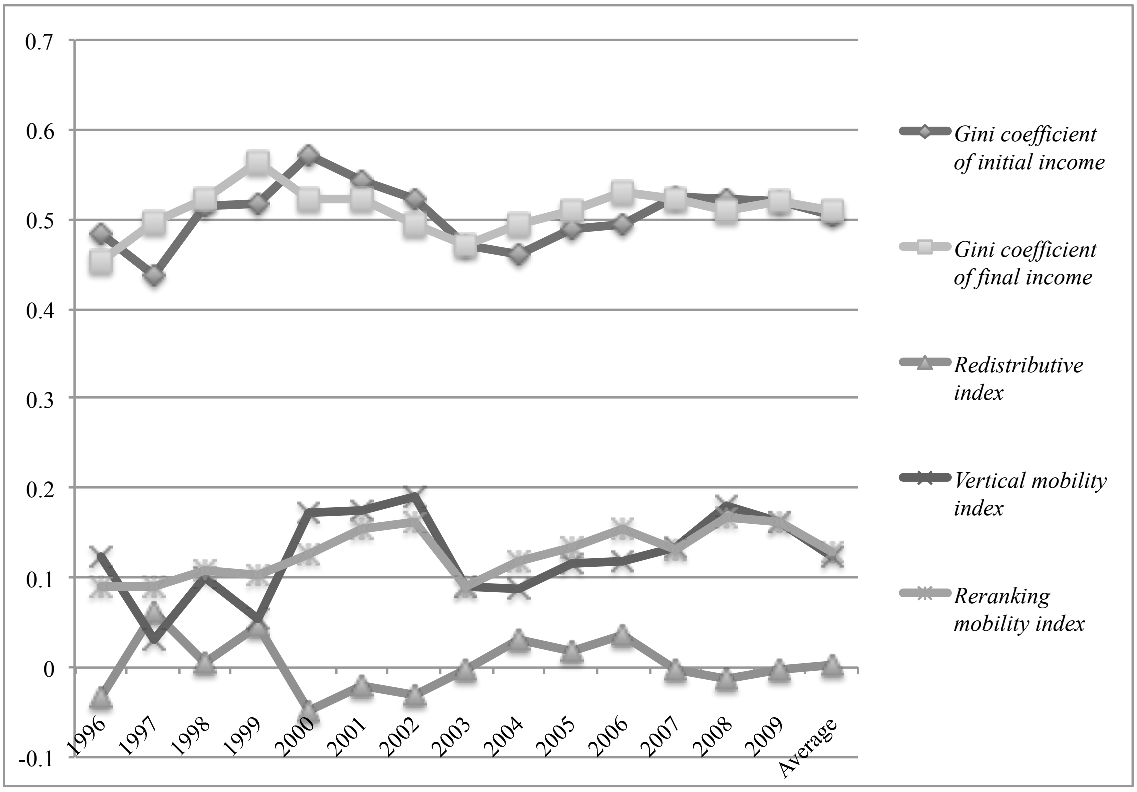


Figure 6.7 graphically present the results of decomposition from Table 6.3; it shows the Gini coefficients, the redistributive index of income changes (measured as the difference between Gini coefficients for initial and final incomes) and the vertical mobility and reranking indices over time.

Whether the change in inequality between two years was negative or positive, income growth was always equalizing as indicated by the positive vertical mobility index in every year, a result that is consistently statistically significant. This means that expected income growth was higher in relative terms for farms with lower initial incomes. As such, the increase in inequality in some of the years resulted from reranking mobility which would more than offset the progressive income growth. The reranking mobility is always zero or positive, serving to increase inequality, since those who move up the income ladder must be better off in the final period than those who move down.

Figure 6.7 Gini coefficient and decomposition indices, annual decompositions 1996-2009.



The statistically significant result of progressivity in expected income growth might suggest that poorer farms grow faster. Such result would contradict Gibrat's empirical law of proportional effect. The following section subjects this result to scrutiny by verifying if the expected income growth is still progressive over multiyear period changes.

6.4.3.2 Multiyear change decomposition

The decomposition of multiyear changes in inequality is useful for two reasons. Firstly, it will serve to inspect if expected income growth remains progressive over few years changes. The results from the annual changes decompositions showed a lot of variability which implies noise in the data; this was reemphasized by the results of the Shorrocks rigidity measure which highlighted the role of transitory shocks in observed inequality. Looking at multiyear changes should increase the degree of systematic structural change relative to noise, which will make it easier to capture the real redistributive nature of income changes and scrutinize the result of progressive income growth in annual changes. Secondly, splitting the multiyear changes around the introduction of the SFP allows seeing if the introduction of decoupled direct payments impacted on the inequality change trends in agricultural incomes.

Table 6.5 presents the results of multiyear analysis which was performed for four subperiods: 1996-2010 to assess the change in inequality for the entire sample period, for subperiods 1996-2005 and 2006-2010 in order to compare the periods before and after the SFP was introduced. This is complemented with an annual change 2005-2006, which looks directly at the change in the year when SFP was introduced. This multiyear analysis uses only the farms present in the dataset over the whole period 1996-2010, which gives a sample of 151 farms; the analysis uses consistent weights for all periods[53]. Table 6.4 presents the breakdown of farms by farm type in this balanced sample, to give a feel of how representative they are. While the restriction to the balanced panel might introduce some bias in the sample, the sample is weighted with

[53] The results from 2005-2006 change decomposition are already included in the annual results, but the decomposition here is recalculated using the same sample and weights as the multiyear changes in the section.

weights adjusted in a way that it still should to be representative of the overall populations.

Table 6.4 Breakdown of balanced panel by farm type.

Number of farms in the sample:

Year	*All*	*Cereal*	*General Cropping*	*Dairy*	*Specialist Sheep*	*Specialist Cattle*	*Cattle & Beef*	*Cattle & Beef Lowland*	*Mixed*
1996	151	1	14	29	18	33	34	2	20
1997	151	3	15	29	17	34	34	2	17
1998	151	6	13	30	18	34	33	1	16
1999	151	5	14	28	21	35	28	2	18
2000	151	2	16	28	21	33	30	2	19
2001	151	3	15	26	21	35	31	2	18
2002	151	4	14	26	21	38	30	2	16
2003	151	3	16	26	21	37	30	1	17
2004	151	7	13	25	16	43	25	1	21
2005	162	8	13	25	15	46	23	21	11
2006	151	11	11	25	16	43	23	1	21
2007	151	11	11	25	16	44	22	1	21
2008	151	11	10	24	17	42	24	2	21
2009	151	8	14	21	16	40	28	2	22
2010	151	9	13	21	16	45	24	1	22

Table 6.5 Multiyear decomposition summary indices

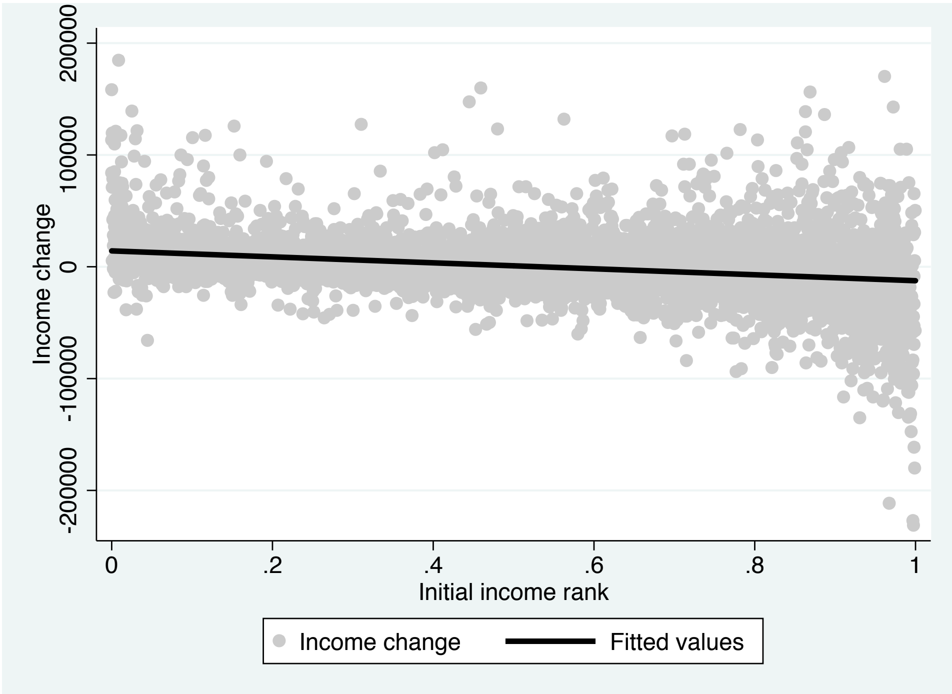
	Mean initial income	*Gini coefficient of initial income*	*Mean final income*	*Gini coefficient of final income*	*CI of final income ranked by initial income*	*Redis-tributive index*	*Vertical mobility index*	*Prog-ressivity index*	*Scale of income change*	*Reranking mobility index*	*Average change in income*
1996	**39747** ***	**0,46** ***	**44480** ***	**0,51** ***	**0,34** ***	**0,05**	**0,11** **	**1,07**	**0,11**	**0,16** ***	**4733**
-2010	*4311*	*0,04*	*5300*	*0,04*	*0,06*	*0,04*	*0,05*	*9,12*	*0,08*	*0,04*	*3680*
1996	**39747** ***	**0,46** ***	**35221** ***	**0,43** ***	**0,28** ***	**-0,03**	**0,18** ***	**-1,38**	**-0,13**	**0,15** ***	**-4526**
-2005	*4311*	*0,04*	*2866*	*0,03*	*0,04*	*0,05*	*0,05*	*15,30*	*0,12*	*0,03*	*3967*
2005	**35221** ***	**0,43** ***	**28907** ***	**0,45** ***	**0,33** ***	**0,01**	**0,10** **	**-0,48**	**-0,22**	**0,12** ***	**-6314**
-2006	*2866*	*0,03*	*2532*	*0,04*	*0,05*	*0,04*	*0,04*	*2,59*	*0,10*	*0,03*	*2426*
2006	**28907** ***	**0,45** ***	**44480** ***	**0,51** ***	**0,38** ***	**0,06**	**0,07**	**0,20**	**0,35** ***	**0,13** ***	**15573** ***
-2010	*2532*	*0,04*	*5300*	*0,04*	*0,05*	*0,05*	*0,05*	*0,17*	*0,07*	*0,03*	*4511*

The results imply an increase of 10% in relative inequality over the whole sample period; this was largely driven by the increase in inequality of 4% in the year the SFP was introduced, and of 13% in the period after its introduction. Between 1996 and the introduction of the SFP in 2005 the inequality decreased by 6%. However, while the values of Gini coefficients are statistically significant, the redistributive effect itself is consistently insignificant.

Like with the annual changes, the analysis reveals that vertical mobility has been positive for all these periods, suggesting that expected income growth was higher in relative terms for farms with lower initial incomes. In 1996-2010 and 2006-2010 periods the progressivity was caused by positive income changes being concentrated proportionally more among farms with lower initial income, whereas in 1996-2005 and 2005-2006 the initially richer farms suffered relatively more of negative income changes. The increase in inequality over the whole sample means that the extent of reranking mobility was big enough to offset the equalizing impact of income growth. These results are statistically significant with the exception of vertical mobility index in period 2006-2010.

More generally, the positive vertical mobility is a result of a double negative or double positive relationship between the progressivity of income changes and their scale, which means that if income changes were on average negative in any given year, they were concentrated among richer farmers. On the other hand, if the average income changes were positive, it was the poorer farmers that benefited from them more. More insight into the nature of this result is gained by looking at Figure 6.8, where income changes over the entire period 1996-2010 are plotted against initial income rank. The figure shows that higher income ranks are in general associated with larger negative changes to income, whereas the lower income ranks experience positive income changes at least as large as farms higher up the income ladder; this implies a degree of regression to the mean. In relative terms, there is a disproportionate concentration of positive income changes among poorer farms.

Figure 6.8 Income change (£) plotted against initial income rank, all years.



Overall, the main continuity between the annual and multiyear results is that vertical mobility index was positive for all the analysed inequality changes, which indicates that relative income changes consistently favoured poorer farmers. The consistency of progressive income growth even for multiyear period gives further support to invalidity of Gibrat's law in Scottish agriculture. However, the fact that positive income changes were concentrated among poorer farms and negative income changes among richer ones could indicate the result of progressivity is driven by transitory shocks which result in regression to the mean, particularly given the earlier demonstration that some proportion of inequality is due to transitory shocks. This possibility is further analysed in the following section.

6.4.3.3 Robustness check of the progressivity

In order to investigate if the result of progressivity in income growth is driven by regression to the mean from transitory shocks, or even measurement error, the approach of Jenkins and van Kerm (2011) is employed. These authors also obtained progressivity of income growth in their analysis and in order to investigate if the result was spurious and driven by a regression to the mean they recalculated the decompositions on data which has been manipulated in two ways:

- by calculating a rolling three-year average for the income measure which smooths out transitory variability,
- by using a so-called *IV method* where the income measure stays unchanged but the ranking is recalculated based on an alternative income measure, which is an average of the one year lag and lead of income, that is $\hat{y}_t = (y_{t-1} + y_{t+1})/2$; this breaks the link between impact of shocks on the initial income and on income growth.

Such transformations allow for better monitoring of substantive variations, thus repeating the analysis on data transformed in these ways provides a robustness check to see if the progressivity is a result of actual structural change in the industry, instead of being driven by noise from transitory, idiosyncratic shocks [54] to incomes or measurement error.

[54] The definition of income used means that any expenditure on investment in a given year will affect the income position of a given farm; if this expenditure is substantial, the impact will be large. For example, if a tractor on a given farm breaks and it chooses to buy a new one and pay for all or most of the amount in the specific year, the individual income shock for that farm will be substantial, which will strongly affect its income change in that year, but also is likely to overstate the extend of reranking. What is more, an investment in a given year, which will constitute a negative income shock, is likely to bring an improvement to the income in the following year/years (assuming the returns are not instant), which will

The necessity of lags and leads limits the period of analysis to 1997-2009. No annual changes are looked at to avoid overlap between years used for calculating the averages; instead the minimum change is 3 years. The multiyear change periods, which are analysed using a balanced panel of farms present across years 1997-2009, are also different than in section 6.4.3.2 to avoid the overlapping, but they are chosen to correspond to the earlier multiyear periods as close as possible; 1997-2009 for the whole sample change, 1997-2005 to show pre-SFP change and 2006-2009 to show post-SFP change[55]. In order to allow for better comparison, the results from *raw* (not manipulated) data were recalculated using corresponding periods.

Table 6.6 presents the corresponding results from raw data, which show that the result of progressivity in income growth is sensitive to the choice of measurement periods; while earlier vertical mobility was consistently positive for all annual changes and the specified multiyear periods, it becomes zero when change over 1997-2009 period is measured and it becomes marginally negative for the change between 2000-2003 (although both of these results are not statistically significant, while the positive vertical mobility for other period changes is statistically significant). This sensitivity of results to the measurement period alone indicates the importance of transitory shocks.

---

drive the regression to the mean mechanism. In this context, the data smoothing techniques will serve as a useful check of results robustness.

[55] The multiyear decompositions also included 2005-2006 but it is skipped here since minimum of 3 years change is required to avoid overlapping.

Table 6.6 Raw data comparison results.

	Mean initial income	*Gini coefficient of initial income*	*Mean final income*	*Gini coefficient of final income*	*CI of final income ranked by initial income*	*Redis-tributive index*	*Vertical mobility index*	*Prog-ressivity index*	*Scale of income change*	*Reranking mobility index*	*Average change in income*
1997	**44052** ***	**0,43** ***	**26230** ***	**0,55** ***	**0,45** ***	**0,12** ***	**-0,02**	**0,03**	**-0,68**	**0,09** ***	**-17822**
-2000	*1591*	*0,01*	*1694*	*0,03*	*0,03*	*0,02*	*0,02*	*0,03*	*0,07*	*0,01*	*1068*
2000	**26793** ***	**0,59** ***	**29845** ***	**0,54** ***	**0,43** ***	**-0,05**	**0,16** ***	**1,59**	**0,10** **	**0,11** ***	**3052** **
-2003	*2433*	*0,03*	*2026*	*0,03*	*0,03*	*0,03*	*0,04*	*37,84*	*0,05*	*0,02*	*1441*
2003	**28558** ***	**0,45** ***	**28150** ***	**0,50** ***	**0,36** ***	**0,05**	**0,09** ***	**-6,26**	**-0,01**	**0,14** ***	**-408**
-2006	*1616*	*0,03*	*1969*	*0,04*	*0,04*	*0,03*	*0,03*	*625,01*	*0,06*	*0,02*	*1532*
2006	**30399** ***	**0,49** ***	**43181** ***	**0,51** ***	**0,37** ***	**0,02**	**0,12** ***	**0,41** ***	**0,30** ***	**0,14** ***	**12782** ***
-2009	*1499*	*0,03*	*2497*	*0,02*	*0,03*	*0,03*	*0,03*	*0,10*	*0,03*	*0,02*	*1697*
1997	**43542** ***	**0,39** ***	**39505** ***	**0,51** ***	**0,40** ***	**0,12** **	**0,00**	**0,04**	**-0,10**	**0,11** ***	**-4037**
-2009	*3868*	*0,03*	*4780*	*0,04*	*0,04*	*0,05*	*0,04*	*6,28*	*0,10*	*0,04*	*3681*
1997	**43542** ***	**0,39** ***	**34298** ***	**0,43** ***	**0,31** ***	**0,04**	**0,08** *	**-0,31**	**-0,27**	**0,12** ***	**-9244**
-2005	*4008*	*0,03*	*3586*	*0,04*	*0,05*	*0,04*	*0,05*	*0,49*	*0,13*	*0,03*	*3896*
2006	**27457** ***	**0,51** ***	**39505** ***	**0,51** ***	**0,41** ***	**0,00**	**0,10** **	**0,33** *	**0,30** ***	**0,10** ***	**12048** ***
-2009	*3270*	*0,05*	*4728*	*0,04*	*0,05*	*0,05*	*0,05*	*0,20*	*0,06*	*0,03*	*3256*

Table 6.7 Three-year rolling average robustness check results.

	Mean initial income	*Gini coefficient of initial income*	*Mean final income*	*Gini coefficient of final income*	*CI of final income ranked by initial income*	*Redis-tributive index*	*Vertical mobility index*	*Prog-ressivity index*	*Scale of income change*	*Reranking mobility index*	*Average change in income*
1997	**36691** ***	**0,45** ***	**26492** ***	**0,49** ***	**0,44** ***	**0,04** **	**0,01**	**-0,02**	**-0,38**	**0,05** ***	**-10199**
-2000	*1725*	*0,02*	*1679*	*0,03*	*0,03*	*0,02*	*0,02*	*0,04*	*0,06*	*0,01*	*1119*
2000	**26966** ***	**0,53** ***	**31050** ***	**0,47** ***	**0,40** ***	**-0,06**	**0,13** **	**0,95**	**0,13** ***	**0,07** ***	**4084** ***
-2003	*2350*	*0,04*	*2065*	*0,04*	*0,04*	*0,05*	*0,05*	*92,49*	*0,05*	*0,01*	*1583*
2003	**32383** ***	**0,41** ***	**31949** ***	**0,45** ***	**0,39** ***	**0,04**	**0,01**	**-0,95**	**-0,01**	**0,06** ***	**-434**
-2006	*1527*	*0,02*	*1790*	*0,03*	*0,03*	*0,03*	*0,02*	*205,26*	*0,04*	*0,02*	*1328*
2006	**34203** ***	**0,45** ***	**44482** ***	**0,46** ***	**0,39** ***	**0,01**	**0,05** **	**0,22** **	**0,23** ***	**0,06** ***	**10279** ***
-2009	*1606*	*0,02*	*2492*	*0,02*	*0,03*	*0,02*	*0,03*	*0,10*	*0,03*	*0,01*	*1588*
1997	**35612** ***	**0,44** ***	**40908** ***	**0,47** ***	**0,38** ***	**0,03**	**0,05**	**0,42**	**0,13** *	**0,09** ***	**5296** *
-2009	*3892*	*0,04*	*5024*	*0,04*	*0,05*	*0,04*	*0,04*	*21,19*	*0,08*	*0,03*	*3196*
1997	**35612** ***	**0,44** ***	**31409** ***	**0,40** ***	**0,31** ***	**-0,04**	**0,12** ***	**-0,93**	**-0,13**	**0,09** ***	**-4203**
-2005	*3915*	*0,04*	*2984*	*0,03*	*0,04*	*0,04*	*0,05*	*3,84*	*0,11*	*0,02*	*3300*
2006	**29911** ***	**0,44** ***	**40908** ***	**0,47** ***	**0,42** ***	**0,03**	**0,02**	**0,08**	**0,27** ***	**0,05** **	**10997** ***
-2009	*3172*	*0,04*	*4946*	*0,04*	*0,04*	*0,04*	*0,04*	*0,16*	*0,06*	*0,02*	*3215*

Comparing these values to results from three-year rolling averages of income in Table 6.7 further confirms the impact of transitory shocks; while the averaging does not lead to reduction of progressivity for every period, overall for most of the periods it is smaller (and it is statistically insignificant for the 4 periods when it is small). This set of results shows that using moving averages reduces the size of the progressivity effect but it does not eliminate it entirely.

Table 6.8 IV method robustness check results.

	Mean initial income	*Gini coefficient of initial income*	*Mean final income*	*Gini coefficient of final income*	*CI of final income ranked by initial income*	*Redis-tributive index*	*Vertical mobility index*	*Prog-ressivity index*	*Scale of income change*	*Reranking mobility index*	*Average change in income*
1997	**43763** ***	**0,37** ***	**26180** ***	**0,45** ***	**0,42** ***	**0,09** ***	**-0,06** **	**0,08** **	**-0,67** ***	**0,03** *	**-17583** ***
-2000	*1880*	*0,02*	*1873*	*0,04*	*0,03*	*0,03*	*0,02*	*0,04*	*0,08*	*0,02*	*1160*
2000	**28571** ***	**0,45** ***	**32077** ***	**0,36** ***	**0,40** ***	**-0,08**	**0,05**	**0,46**	**0,11** **	**-0,03**	**3506** *
-2003	*2887*	*0,04*	*2868*	*0,06*	*0,05*	*0,07*	*0,04*	*39,46*	*0,06*	*0,05*	*1817*
2003	**29596** ***	**0,33** ***	**28761** ***	**0,40** ***	**0,34** ***	**0,06** *	**-0,01**	**0,32**	**-0,03**	**0,05** *	**-835**
-2006	*1590*	*0,03*	*1957*	*0,04*	*0,04*	*0,04*	*0,03*	*8,35*	*0,06*	*0,03*	*1659*
2006	**30555** ***	**0,40** ***	**42643** ***	**0,39** ***	**0,39** ***	**-0,01**	**0,01**	**0,03**	**0,28** ***	**0,00**	**12088** ***
-2009	*1668*	*0,03*	*2630*	*0,03*	*0,03*	*0,03*	*0,03*	*0,09*	*0,03*	*0,02*	*1757*
1997	**43542** ***	**0,33** ***	**39505** ***	**0,42** ***	**0,35** ***	**0,09** *	**-0,02**	**0,19**	**-0,10**	**0,07** *	**-4037**
-2009	*4039*	*0,04*	*4851*	*0,05*	*0,05*	*0,05*	*0,05*	*10,26*	*0,10*	*0,04*	*3684*
1997	**43542** ***	**0,33** ***	**34298** ***	**0,34** ***	**0,28** ***	**0,01**	**0,05**	**-0,19**	**-0,27**	**0,06**	**-9244**
-2005	*3830*	*0,04*	*3502*	*0,05*	*0,05*	*0,06*	*0,05*	*0,84*	*0,12*	*0,05*	*3797*
2006	**27457** ***	**0,43** ***	**39505** ***	**0,42** ***	**0,41** ***	**-0,01**	**0,01**	**0,04**	**0,30** ***	**0,01**	**12048** ***
-2009	*3358*	*0,05*	*4761*	*0,05*	*0,05*	*0,05*	*0,05*	*0,18*	*0,06*	*0,03*	*3237*

Table 6.8 provides the summary indices from the decomposition using the IV method, which removes the link between current income and current rank. This way of manipulating the data means that a current shock to the income will not drastically affect the rank in this year. The statistical significance of these results is very low, with vertical mobility index statistically significant at 5% only for 1997-2000 change. As can be seen, the delinking significantly impacts the values of vertical mobility. Specifically, the vertical mobility index is largely reduced; for some periods it is positive, for others negative, but generally it oscillates in the proximity of zero. The delinking, which purges incomes shocks from the ranks, almost entirely eliminates the progressivity result which suggests that the progressivity of income growth from the raw data analysis is not driven by a structural change in the industry which favours the poorer farms; it is instead a result of transitory shocks to income which cause regression to the mean.

Overall, the robustness results show some mixed results. Extending the measurement period with the use of multiyear changes supports the finding of progressive expected income growth. When the analysis is done on three-year rolling averages of data, the progressivity is reduced but not eliminated entirely. Given these results, it could be concluded that not all progressivity is simply regression to the mean from transitory shocks. However, the IV approach showed that breaking the link between the ranking of income and income change eliminates the progressivity, which suggests that neither richer nor poorer farms are favoured by structural developments in the industry. Based on these mixed results, it can be concluded that expected income growth is progressive, but only minor part of this is due to systematic structural change and majority is due to transitory shocks that cause regression to the mean, since farms that suffered a bad shock in one year are likely to recover the following season, and vice versa – farms which experienced a positive transitory shock are likely to have a worse next season.

6.4.4 Vertical mobility decomposition

This section provides a further subdecomposition of one of the components of the Jenkins and van Kerm (2006) decomposition of change in inequality by exploring the systematic forces driving vertical mobility, based on the approach of Allanson and Petrie (2013). The big question addressed by the vertical mobility index is whether relative income changes favour those who are initially poor or those who are initially rich. However, the vertical mobility index alone will provide a misleading picture of how much relative income changes are linked to initial income, since initial income is not the only factor affecting these changes. Other factors which impact on income growth and are correlated with initial income may also play role. The decomposition presented in this section allows to determine the contributions of inequalities in all the determinants of income growth to vertical mobility.

The decomposition analysis builds upon the Error Correction Model of agricultural income from chapter 5. First the results from the decomposition of vertical mobility in annual changes will be presented, followed by the decomposition of vertical mobility in multiyear changes.

6.4.4.1 Annual changes

Table 6.9 presents the decomposition of the vertical mobility index using equation (6.10) from the methodology section. The decomposition identifies the contributions to vertical mobility of:

- the change terms in the income function which represent the short term impact of changes in the economic size of cropping and livestock enterprises,
- the disequilibrium error which shows the adjustment towards the equilibrium income,
- the residual which represents idiosyncratic income shocks.

The absolute contributions of each component to vertical mobility are plotted in Figure 6.9, with Figure 6.10 showing the relative contributions to total vertical mobility.

The contributions of changes in the economic size of both livestock and cropping enterprises are very minor and statistically insignificant in all years. This negligible impact can be seen well in both figures, where in absolute and relative terms the contributions are miniscule in comparison with those from the residual and the disequilibrium error.

Table 6.9 Vertical mobility decomposition, annual changes 1996-2009.

		ECM parameter	q	P	Vertical mobility due to component	% share of overall vertical mobility
1996	Δ Cropping SGM	0,123 **	0,005 *	0,094	0,0005	0,4%
		0,061	0,003	0,157	0,0009	
	Δ Livestock SGM	0,119 *	0,000	-2,064	0,0004	0,3%
		0,069	0,001	49,722	0,0008	
	Disequilibrium error	0,494 ***	0,034	2,300	0,0778 ***	63,3%
		0,021	0,038	45,524	0,0087	
	Residual	-	0,039	1,139	0,0442 ***	36,0%
		-	0,020	290,049	0,0153	
	Overall vertical mobility	-	0,078	1,580	0,1229	100,0%
1997	Δ Cropping SGM	0,123 **	0,007 *	0,003	0,0000	0,1%
		0,064	0,004	0,234	0,0018	
	Δ Livestock SGM	0,119 *	0,001	0,594	0,0007	2,3%
		0,065	0,002	14,113	0,0010	
	Disequilibrium error	0,494 ***	-0,507 ***	-0,086 ***	0,0438 ***	144,8%
		0,022	0,044	0,019	0,0089	
	Residual	-	-0,061 ***	0,233	-0,0143	-47,2%
		-	0,019	0,452	0,0173	
	Overall vertical mobility	-	-0,561	-0,054	0,0302	100,0%
1998	Δ Cropping SGM	0,123 **	-0,004	0,191	-0,0008	-0,8%
		0,065	0,003	1,223	0,0010	
	Δ Livestock SGM	0,119 *	0,001	-0,229	-0,0002	-0,2%
		0,068	0,001	12,332	0,0006	
	Disequilibrium error	0,494 ***	0,049	2,274	0,1123 ***	110,6%
		0,021	0,035	20,035	0,0210	
	Residual	-	0,001	-11,134	-0,0097	-9,6%
		-	0,020	171,946	0,0279	
	Overall vertical mobility	-	0,047	2,148	0,1016	100,0%
1999	Δ Cropping SGM	0,123 **	0,011 *	0,189	0,0021	3,7%
		0,063	0,007	0,181	0,0026	
	Δ Livestock SGM	0,119 *	0,000	2,990	-0,0008	-1,4%
		0,070	0,001	8,804	0,0008	
	Disequilibrium error	0,494 ***	-0,058	-1,705	0,0990 ***	178,4%
		0,022	0,038	28,262	0,0240	
	Residual	-	-0,047 ***	0,961	-0,0448 *	-80,8%
		-	0,017	0,797	0,0266	
	Overall vertical mobility	-	-0,094	-0,590	0,0555	100,0%
2000	Δ Cropping SGM	0,123 *	0,000	0,701	0,0001	0,0%
		0,064	0,002	21,120	0,0010	
	Δ Livestock SGM	0,119 *	-0,002	0,541	-0,0011	-0,6%
		0,066	0,001	1,092	0,0008	
	Disequilibrium error	0,494 ***	0,075 *	2,113	0,1575 ***	90,8%
		0,020	0,044	233,228	0,0244	
	Residual	-	0,001	17,017	0,0170	9,8%
		-	0,022	79,020	0,0221	
	Overall vertical mobility	-	0,074	2,355	0,1735	100,0%
2001	Δ Cropping SGM	0,123 *	-0,003	0,903	-0,0030	-1,7%
		0,065	0,003	248,748	0,0027	
	Δ Livestock SGM	0,119 *	-0,001	1,890	-0,0014	-0,8%
		0,065	0,001	891,397	0,0010	
	Disequilibrium error	0,494 ***	0,160 ***	1,104	0,1771 ***	100,9%
		0,021	0,050	5,831	0,0167	
	Residual	-	-0,037	-0,074	0,0028	1,6%
		-	0,023	31,012	0,0244	
	Overall vertical mobility	-	0,119	1,473	0,1755	100,0%
2002	Δ Cropping SGM	0,123 **	0,001	-0,724	-0,0010	-0,5%
		0,063	0,002	41,105	0,0014	
	Δ Livestock SGM	0,119 *	-0,001	0,196	-0,0002	-0,1%
		0,066	0,002	1,105	0,0014	
	Disequilibrium error	0,494 ***	-0,057	-2,009	0,1136 ***	59,3%
		0,022	0,045	20,603	0,0211	
	Residual	-	0,052 **	1,525	0,0793 ***	41,4%
		-	0,022	4,787	0,0257	
	Overall vertical mobility	-	-0,004	-44,785	0,1916	100,0%

		ECM parameter	q	P	Vertical mobility due to component	% share of overall vertical mobility
2003	*Δ Cropping SGM*	**0,123** *	**0,002**	**0,343**	**0,0008**	**0,9%**
		0,065	*0,004*	*545,419*	*0,0023*	
	Δ Livestock SGM	**0,119** *	**0,001**	**-0,048**	**0,0000**	**0,0%**
		0,067	*0,001*	*4,105*	*0,0005*	
	Disequilibrium error	**0,494** ***	**0,119** ***	**0,948**	**0,1131** ***	**124,8%**
		0,022	*0,033*	*0,650*	*0,0153*	
	Residual	**-**	**-0,011**	**2,159**	**-0,0232**	**-25,6%**
		-	*0,017*	*145,990*	*0,0172*	
	Overall vertical mobility	**-**	**0,112**	**0,810**	**0,0907**	**100,0%**
2004	*Δ Cropping SGM*	**0,123** *	**0,006**	**0,290**	**0,0016**	**1,9%**
		0,064	*0,004*	*0,224*	*0,0016*	
	Δ Livestock SGM	**0,119** *	**0,000**	**-0,804**	**-0,0001**	**-0,1%**
		0,066	*0,001*	*5,047*	*0,0009*	
	Disequilibrium error	**0,494** ***	**-0,039**	**-2,373**	**0,0924** ***	**106,4%**
		0,021	*0,042*	*35,463*	*0,0114*	
	Residual	**-**	**-0,004**	**1,967**	**-0,0071**	**-8,1%**
		-	*0,022*	*13,221*	*0,0214*	
	Overall vertical mobility	**-**	**0,037**	**-2,359**	**0,0869**	**100,0%**
2005	*Δ Cropping SGM*	**0,123** *	**-0,003**	**0,530**	**-0,0017**	**-1,5%**
		0,064	*0,004*	*295,963*	*0,0031*	
	Δ Livestock SGM	**0,119** *	**0,000**	**-5,472**	**0,0007**	**0,6%**
		0,066	*0,001*	*50,342*	*0,0011*	
	Disequilibrium error	**0,494** ***	**-0,161** ***	**-0,545** *	**0,0877** ***	**76,1%**
		0,021	*0,042*	*0,286*	*0,0139*	
	Residual	**-**	**0,015**	**1,950**	**0,0286**	**24,8%**
		-	*0,022*	*12,932*	*0,0235*	
	Overall vertical mobility	**-**	**-0,150**	**-0,771**	**0,1153**	**100,0%**
2006	*Δ Cropping SGM*	**0,123** *	**-0,001**	**0,430**	**-0,0004**	**-0,3%**
		0,065	*0,002*	*22,526*	*0,0013*	
	Δ Livestock SGM	**0,119** *	**0,000**	**-0,085**	**0,0000**	**0,0%**
		0,068	*0,001*	*11,427*	*0,0012*	
	Disequilibrium error	**0,494** ***	**0,187** ***	**0,931** ***	**0,1741** ***	**146,5%**
		0,022	*0,045*	*0,300*	*0,0226*	
	Residual	**-**	**-0,076** ***	**0,721**	**-0,0549** **	**-46,2%**
		-	*0,022*	*0,332*	*0,0230*	
	Overall vertical mobility	**-**	**0,110**	**1,083**	**0,1188**	**100,0%**
2007	*Δ Cropping SGM*	**0,123** **	**0,001**	**-0,581**	**-0,0004**	**-0,3%**
		0,060	*0,001*	*846,767*	*0,0006*	
	Δ Livestock SGM	**0,119** *	**0,001**	**0,412**	**0,0006**	**0,5%**
		0,070	*0,001*	*8,768*	*0,0009*	
	Disequilibrium error	**0,494** ***	**0,311** ***	**0,539** ***	**0,1677** ***	**124,8%**
		0,021	*0,027*	*0,059*	*0,0201*	
	Residual	**-**	**-0,039** **	**0,851**	**-0,0335**	**-24,9%**
		-	*0,017*	*15,583*	*0,0204*	
	Overall vertical mobility	**-**	**0,274**	**0,491**	**0,1344**	**100,0%**
2008	*Δ Cropping SGM*	**0,123** *	**0,007** *	**0,006**	**0,0000**	**0,0%**
		0,066	*0,004*	*0,092*	*0,0006*	
	Δ Livestock SGM	**0,119** *	**-0,004**	**0,321**	**-0,0013**	**-0,7%**
		0,065	*0,003*	*0,174*	*0,0011*	
	Disequilibrium error	**0,494** ***	**-0,148** **	**-0,909**	**0,1342** ***	**74,5%**
		0,022	*0,058*	*6,648*	*0,0149*	
	Residual	**-**	**0,034**	**1,411**	**0,0473** **	**26,2%**
		-	*0,028*	*31,766*	*0,0229*	
	Overall vertical mobility	**-**	**-0,112**	**-1,613**	**0,1802**	**100,0%**
2009	*Δ Cropping SGM*	**0,123** *	**-0,001**	**2,275**	**-0,0017**	**-1,0%**
		0,063	*0,002*	*41,105*	*0,0014*	
	Δ Livestock SGM	**0,119** *	**-0,002**	**0,568**	**-0,0012**	**-0,7%**
		0,066	*0,002*	*1,105*	*0,0014*	
	Disequilibrium error	**0,494** ***	**0,016**	**9,275**	**0,1475** ***	**90,3%**
		0,021	*0,044*	*1185,881*	*0,0221*	
	Residual	**-**	**0,002**	**8,417**	**0,0187**	**11,4%**
		-	*0,025*	*21,037*	*0,0257*	
	Overall vertical mobility	**-**	**0,015**	**10,662**	**0,1634**	**100,0%**

Figure 6.9 Absolute contributions to vertical mobility, annual changes 1996-2009.

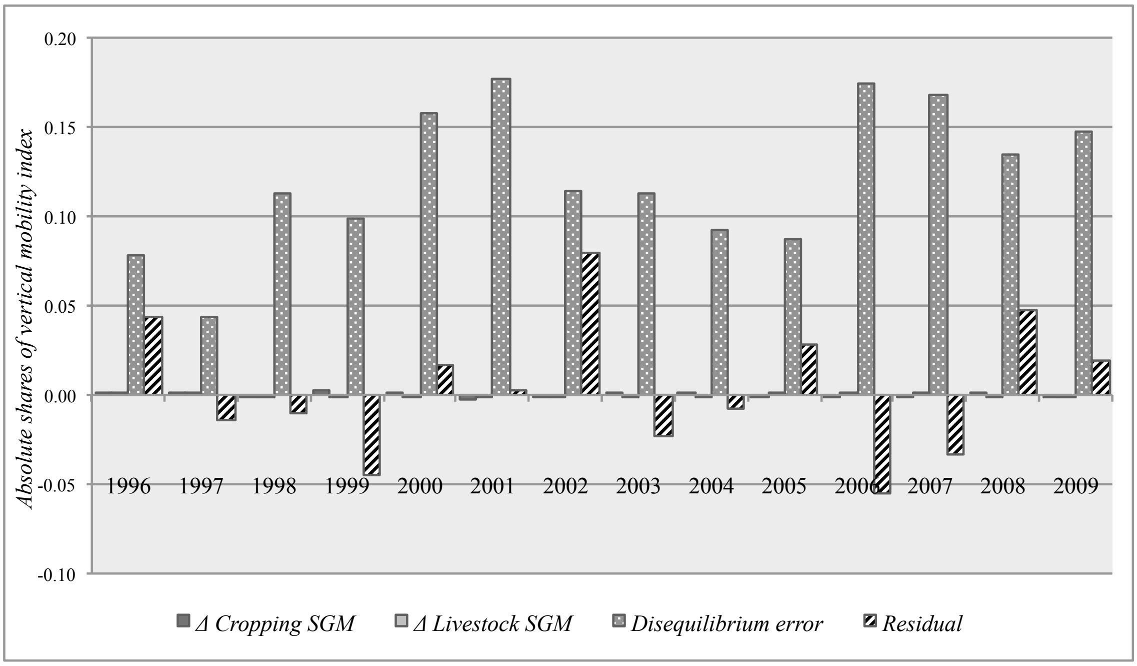
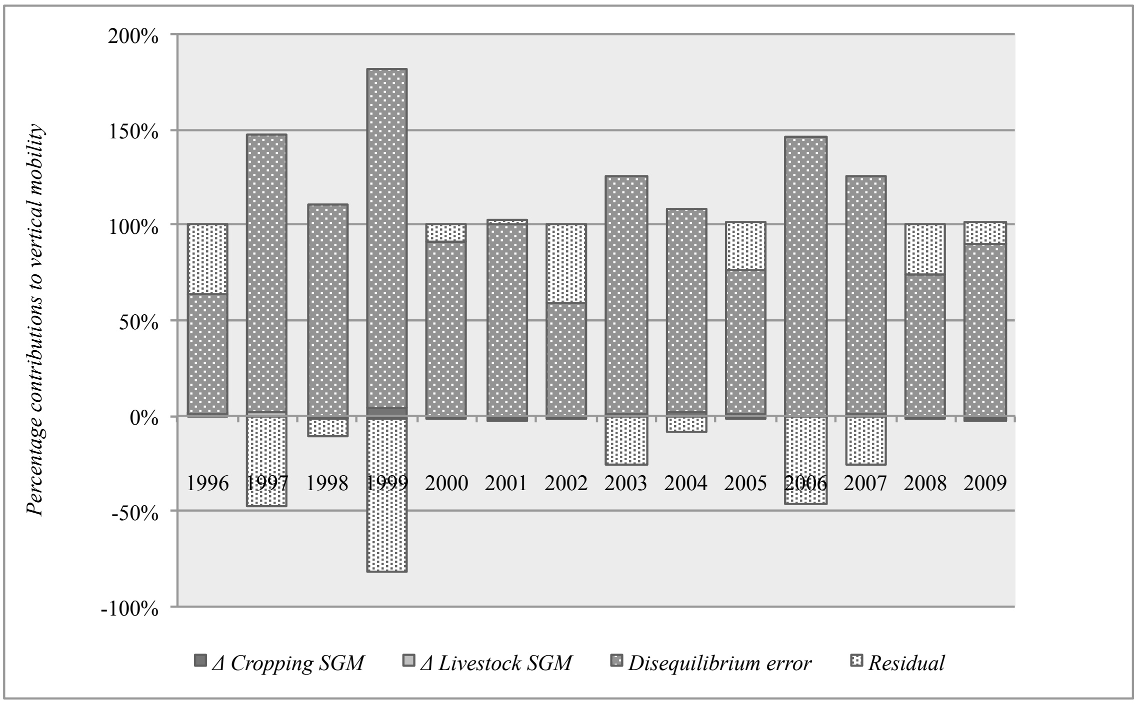


Figure 6.10 Percentage contributions to vertical mobility, annual changes 1996-2009.



From these results we can conclude that changes in enterprise size structures did not play a major role in accounting for annual changes in inequality due to income growth over the period of 1996-2010. Whether structural change is also of minor importance over longer time horizons is investigated later on with the use of multiyear change decompositions.

The disequilibrium error term represents the lagged adjustment of the deviation from equilibrium in a previous year. Generally, one can see that the contribution of the disequilibrium error to vertical mobility is positive in every year, meaning that the adjustment towards equilibrium is always equalizing. As shown in equation (6.11), the sign of the contribution from the disequilibrium error will be determined by the relationship between the actual inequality and the inequality of equilibrium incomes. The equalizing impact of the disequilibrium error implies therefore that the equilibrium inequality is smaller than the actual inequality. This is in line with expectations given the intuition behind Shorrocks rigidity index (and the results of the index in section 6.4.2). The long-run inequality is smaller than the actual inequality because transitory shocks to income are noise around the equilibrium relationship and they constitute an additional source of inequality. The equilibrium relationship (as specified by income model from chapter 5) shifts in response to common income shocks in a given year, therefore the additional inequality in actual incomes is caused by idiosyncratic income shocks.

The contribution of the disequilibrium error is consistently statistically significant at 1% level, being the only statistically significant factor in the decomposition. The average contribution of the disequilibrium error is 107%, thus it is the main equalizing force behind the progressivity of the individual income growth, in some years being offset and it others reinforced by contribution of the residual.

The residual component captures the impact of idiosyncratic income shocks to farms' incomes on vertical mobility. After controlling for time fixed effects and farms fixed effects, there should be on average no association between incomes and residuals, and therefore residuals capture true random shocks which are on average zero at any given level of initial income. This leads to an *a priori* expectation that the share of the residual in vertical mobility should oscillate around zero; this is supported by the fact that the contribution was positive in 7 years and negative in 7 years, and that the effect is mostly statistically insignificant at 10% level, which implies that idiosyncratic income shocks have no systematic impact on expected income growth.

Overall, the results indicate that the majority of vertical mobility is driven by the disequilibrium adjustment while the short-run effects of changes in the economic size are negligible, indicating the minor role of structural change in annual inequality changes. In this context, it is particularly useful to look at a multiyear perspective in order to get more insight into the possible role played by structural changes in the longer term.

Furthermore, the results of the decomposition of annual vertical mobility reveal no clear differences between those for the subperiods 1996-2005 and 2006-2010, implying that the introduction of the SPS did not appear have an impact on the contributions of income determinants to vertical mobility, or at least not one that could be detected by this methodology. The multiyear approach will allow investigating this further.

6.4.4.2 Multiyear changes

The multiyear decomposition is performed using the same subperiods and indices as in section 6.4.3.2, that is 1996-2010 to assess the change in inequality for the entire sample period, subperiods 1996-2005 and 2006-2010 in order to compare the periods before and after the SFP was introduced, and the annual change 2005-2006 which looks directly at the year of the SFP introduction. As before, these results are based on balanced panel of 151 farms present in the dataset throughout 1996 to 2010, with the use of consistent weights for all periods.

Table 6.10 presents the decomposition of vertical income mobility from multiyear changes using equation (6.14). from methodology section. The decomposition identifies the contributions to vertical mobility of:

- the combined effect of changes in the economic size of cropping and livestock enterprises in the multiyear period,
- the combined disequilibrium error impact,
- the combined residual impact.

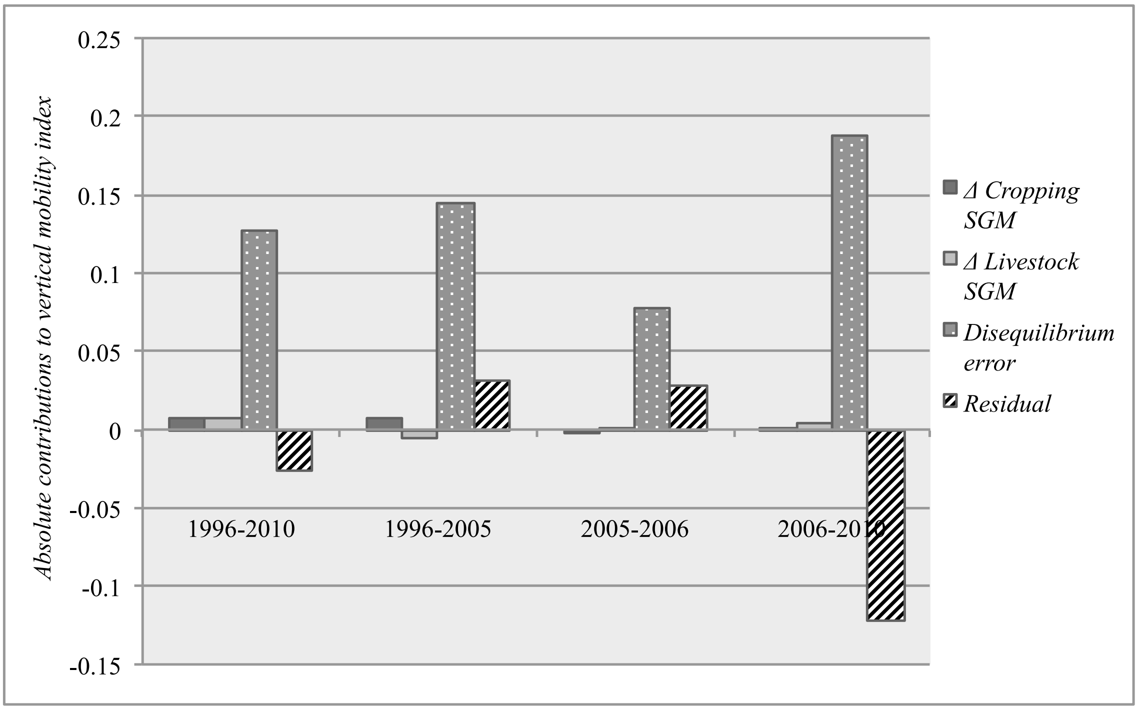
Figures 6.11 and 6.12 plot the results to facilitate interpretation; Figure 6.11 in terms of absolute contributions to the vertical mobility index and Figure 6.12 in percentage terms as a share of vertical mobility.

Table 6.10 Vertical mobility decomposition, multiyear changes.

		ECM parameter	*q*	*P*	*Vertical mobility due to component*	*% share of overall vertical mobility*
1996	*Δ Cropping SGM*	**0,123**	**-0,009**	**-0,759**	**0,0067**	**5,8%**
-		*0,075*	*0,024*	*6,008*	*0,0097*	
2010	*Δ Livestock SGM*	**0,119**	**0,018**	**0,413**	**0,0075**	**6,5%**
		0,078	*0,031*	*78,715*	*0,0218*	
	Disequilibrium error	**0,494** ***	**0,001**	**129,352**	**0,1269** ***	**111,3%**
		0,032	*0,060*	*146,400*	*0,0281*	
	Residual	**-**	**0,096**	**-0,281**	**-0,0270**	**-23,7%**
		-	*0,071*	*14,307*	*0,0435*	
	Overall vertical mobility	**-**	**0,106**	**1,071**	**0,1140**	**100,0%**
1996	*Δ Cropping SGM*	**0,123**	**-0,002**	**-3,382**	**0,0077**	**4,3%**
-		*0,075*	*0,018*	*9,795*	*0,0096*	
2005	*Δ Livestock SGM*	**0,119**	**0,006**	**-0,926**	**-0,0054**	**-3,0%**
		0,078	*0,024*	*49,510*	*0,0151*	
	Disequilibrium error	**0,494** ***	**-0,156** *	**-0,927**	**0,1450** ***	**81,5%**
		0,032	*0,086*	*23,530*	*0,0330*	
	Residual	**-**	**0,024**	**1,262**	**0,0307**	**17,3%**
		-	*0,073*	*25,636*	*0,0389*	
	Overall vertical mobility	**-**	**-0,129**	**-1,385**	**0,1780**	**100,0%**
2005	*Δ Cropping SGM*	**0,123**	**-0,009**	**0,319**	**-0,0028**	**-2,7%**
-		*0,075*	*0,009*	*13,469*	*0,0068*	
2006	*Δ Livestock SGM*	**0,119**	**-0,001**	**-1,840**	**0,0016**	**1,5%**
		0,078	*0,003*	*7,972*	*0,0021*	
	Disequilibrium error	**0,494** ***	**-0,176** ***	**-0,440**	**0,0775** ***	**74,1%**
		0,032	*0,052*	*0,448*	*0,0212*	
	Residual	**-**	**-0,032**	**-0,874**	**0,0283**	**27,1%**
		-	*0,080*	*6,433*	*0,0407*	
	Overall vertical mobility	**-**	**-0,218**	**-0,479**	**0,1046**	**100,0%**
2006	*Δ Cropping SGM*	**0,123**	**0,001**	**0,806**	**0,0010**	**2,1%**
-		*0,075*	*0,011*	*25,001*	*0,0057*	
2010	*Δ Livestock SGM*	**0,119**	**0,019**	**0,222**	**0,0042**	**8,8%**
		0,078	*0,018*	*84,795*	*0,0132*	
	Disequilibrium error	**0,494** ***	**0,233** ***	**0,803** **	**0,1873** ***	**397,2%**
		0,032	*0,064*	*0,323*	*0,0520*	
	Residual	**-**	**0,097**	**-1,261**	**-0,1222** ***	**-259,0%**
		-	*0,070*	*22,674*	*0,0420*	
	Overall vertical mobility	**-**	**0,069**	**0,168**	**0,0472**	**100,0%**

Over the entire sample period 1996-2010, changes in both cropping and livestock shares of the economic size served to reduce the inequality. The average growth of SGM for cropping enterprises in the entire period was negative; this means that cropping enterprises on average got smaller (and hence the share of income from them also decreased) and these losses were concentrated among farms with larger initial income. For livestock, on the other hand, the positive scale of income changes reflects the fact that livestock enterprises grew on average over the entire sample period and consequently income growth from these changes was positive; farms with lower income in 1996 experienced higher relative growth rates. Changes in both cropping and livestock SGM contributed around 6% each to the vertical mobility over this period. Although this cumulative result is somewhat higher than for the individual annual changes in section 6.4.3, the role of structural change in inequality is still relatively minor – jointly growth of both types of enterprises accounted for little over 12% of vertical mobility (which is largely due to the relative small contribution of enterprise size changes to the overall growth in average income) and the result is statistically insignificant.

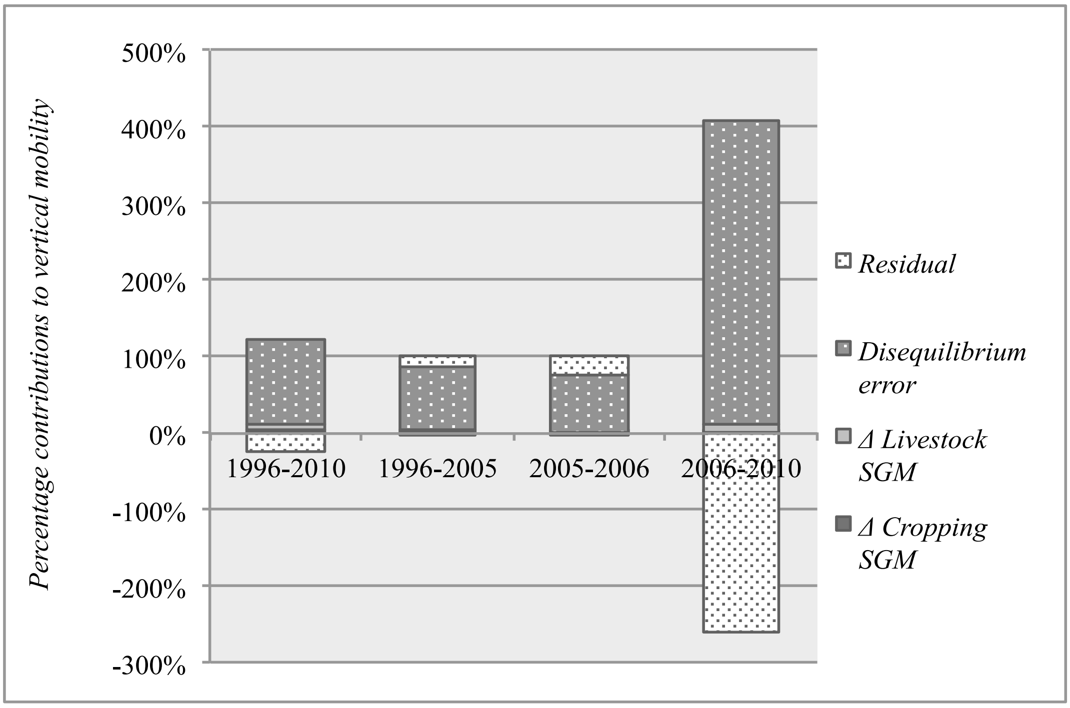
Figure 6.11 Absolute contributions to vertical mobility, multiyear changes.



Similarly to the annual change results, the disequilibrium adjustment acted in an equalizing manner - specifically through positive income changes that were pro-poor in nature, and it is the only factor that is statistically significant. Accordingly, it was the main equalizing force behind the progressivity of expected income growth, accounting for more than 100% of overall vertical mobility. The idiosyncratic income shocks had a disequalizing impact since they reduced vertical mobility by around 24%, but their contribution is not statistically significantly different from zero.

For the subperiods, the impact of economic size changes is always small and statistically insignificant. The disequilibrium error adjustment remains the main equalizing force and is consistently statistically significant. The impact of idiosyncratic shocks on vertical mobility was statistically insignificant with the exception of 2006 - 2010 period.

Figure 6.12 Percentage contributions to vertical mobility, multiyear changes.



The key finding from this analysis is the unimportance of structural change even over the full sample period – while its magnitude increases slightly, it is still very small compared to the disequilibrium adjustment, and remains statistically insignificant. This highlights the dominant impact of transitory shocks over structural change on inequality changes over the studied period. Furthermore, the structural change did not play significant role in vertical mobility both before and after the introduction of the SFP.

6.4.5 Equilibrium inequality

Modelling the long-run equilibrium income relationship allows us to quantify the extent of structural, or chronic, inequality in agricultural incomes. This section starts with a discussion of how the equilibrium inequality links with the concept of mobility as income risk, followed by an analysis of the determinants of equilibrium inequality.

6.4.5.1 Mobility as income risk

Table 6.11 presents the information on mean actual[56] and equilibrium incomes in each year, as well as the corresponding Gini coefficients. Figure 6.13 provides a graphic representation of the two Gini coefficients over time.

As can be seen from Figure 6.13, the Gini coefficient of the equilibrium incomes is lower than that of actual observed incomes in each year of the analysis, with the exception of 1997. Like the equalizing impact of disequilibrium error on vertical mobility, this indicates that the equilibrium, or chronic, inequality in the industry is less than the observed levels of inequality in any given year. The difference between the Gini of actual and equilibrium incomes captures the idea of mobility as income risk, illustrating the last concept of mobility distinguished by Jantti and Jenkins (2013). This concept of mobility closely links with the idea of equalization of longer-term incomes

---

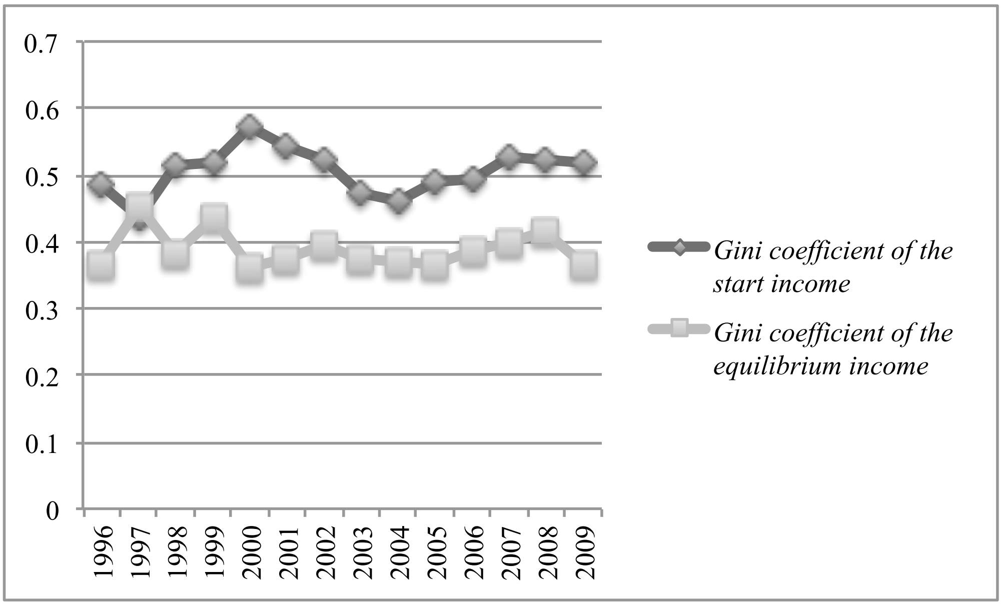
[56] This corresponds to the initial income values earlier on.

as shown by Shorrocks rigidity index. In Shorrocks' case, individual's income in any period is a sum of a *permanent* and a *transitory* components, as measured by the longer-term average and the deviation from it. However, in the case here, the permanent part of the income is modelled and is given a behavioural interpretation in the sense that it represents expected future income. In this context, the deviation from that expectation, the transitory component, represents an unexpected income shock, and the larger the dispersion of these shocks across individuals, the larger is income risk for the population. In the income model the common shocks to all incomes caused by given year's conditions shift the equilibrium relationship, while the idiosyncratic income shocks cause a deviation from this equilibrium (and increase the level of inequality).

Table 6.11 Equilibrium inequality summary indices, 1996-2009.

	Mean (initial) income	*Gini coefficient of the initial income*	*Mean equilibrium income*	*Gini coefficient of the equilibrium income*	*Average difference between equilibrium and actual incomes*	*Difference between actual and equilibrium income Gini coefficients (income risk proxy)*
1996	**39096** ***	**0,48** ***	**42001** ***	**0,37** ***	**2905**	**-0,12** ***
	1480	*0,02*	*3032*	*0,01*	*3153*	*0,02*
1997	**44144** ***	**0,44** ***	**15069** ***	**0,45** ***	**-29076** ***	**0,02**
	1356	*0,01*	*2183*	*0,11*	*2538*	*0,11*
1998	**27955** ***	**0,52** ***	**30891** ***	**0,38** ***	**2936**	**-0,13** ***
	1074	*0,02*	*2100*	*0,02*	*2189*	*0,03*
1999	**29965** ***	**0,52** ***	**26744** ***	**0,44** ***	**-3221**	**-0,08** *
	1403	*0,03*	*1967*	*0,03*	*1971*	*0,04*
2000	**26842** ***	**0,57** ***	**31218** ***	**0,36** ***	**4375** *	**-0,21** ***
	1624	*0,03*	*2478*	*0,02*	*2620*	*0,03*
2001	**27719** ***	**0,54** ***	**37945** ***	**0,37** ***	**10225** ***	**-0,17** ***
	1729	*0,02*	*2399*	*0,02*	*3129*	*0,02*
2002	**31131** ***	**0,52** ***	**27582** ***	**0,40** ***	**-3550**	**-0,13** ***
	1403	*0,02*	*2606*	*0,03*	*2766*	*0,03*
2003	**32660** ***	**0,47** ***	**41547** ***	**0,37** ***	**8887** ***	**-0,10** ***
	1747	*0,02*	*2528*	*0,02*	*2533*	*0,02*
2004	**37498** ***	**0,46** ***	**34646** ***	**0,37** ***	**-2853**	**-0,09** ***
	1613	*0,02*	*2946*	*0,03*	*2990*	*0,03*
2005	**35877** ***	**0,49** ***	**25709** ***	**0,37** ***	**-10168** ***	**-0,12** ***
	1735	*0,02*	*2364*	*0,02*	*2484*	*0,03*
2006	**32302** ***	**0,49** ***	**46048** ***	**0,39** ***	**13746** ***	**-0,11** ***
	1539	*0,02*	*3730*	*0,02*	*3815*	*0,03*
2007	**37130** ***	**0,53** ***	**69346** ***	**0,40** ***	**32217** ***	**-0,13** ***
	1742	*0,02*	*4048*	*0,01*	*3760*	*0,02*
2008	**52203** ***	**0,52** ***	**38158** ***	**0,42** ***	**-14046** ***	**-0,11**
	2315	*0,02*	*4794*	*0,08*	*5300*	*0,09*
2009	**48785** ***	**0,52** ***	**50381** ***	**0,36** ***	**1596**	**-0,16** ***
	2183	*0,02*	*4120*	*0,02*	*4415*	*0,02*

Figure 6.13 Gini coefficients of start and equilibrium incomes, 1996-2009.



The crucial difference between the earlier concept of income mobility as a reduction of longer-term inequality and that of income risk is its normative interpretation. The concept of mobility as reduction of longer-term inequality focuses on the reduction of inequality once the transitory shocks are smoothed out. The larger is the difference between the inequality of actual incomes and the inequality of long-term average incomes, the more exchange mobility there is, and such mobility is generally seen as a desirable thing. But there is a flipside to this situation, which has already been pointed out by Shorrocks:

> "Changes in relative incomes still tend over time to equalise the distribution of total income receipts, and to this extent welfare is improved. But greater variability of incomes about the same average level is disliked by individuals who prefer a stable flow. So to the extent that mobility leads to more pronounced fluctuations and more uncertainty, it is not regarded as socially desirable."

(Shorrocks, 1978a, p. 392-393)

Therefore in the case when individuals are not indifferent between two income streams offering the same real present value, which will be the case for risk-averse individuals when capital markets are imperfect and consumption cannot be easily smoothed out, the uncertainty associated with a fluctuating income stream is undesirable. As such, in spite of the long-run inequality-reducing impact of income mobility, mobility might no longer be socially desirable if it entails transitory income shocks, since it will also be associated with unpredictability and insecurity (Jantti and Jenkins, 2013). In this context, an individual might prefer being relatively poorer if his/her income flow is more stable overtime, rather than having a higher overall income but with larger intertemporal fluctuations. This stems from risk-aversion and preference for income stability, which facilitates better planning for the future.

The results show that in most years the share of inequality due to transitory shocks to equilibrium income is at least 20%, and it was as high as 37% in 2000. This indicates a substantial degree of income risk, and confirms the already mentioned instability of agricultural incomes. These figures are slightly higher than the results of Shorrocks measure, which indicated that over a longer-period 14% of cross-sectional inequality is due to transitory shocks. However, both measures show that transitory shocks do matter but overwhelming majority of inequality is structural in nature.

6.4.5.2 Equilibrium inequality decomposition

The Gini coefficient of the equilibrium inequality is decomposed in order to gain some insight into the determinants of equilibrium inequality. The decomposition is done using the coefficients from the equilibrium relationship implied by the income model from chapter 5, following equation (6.15). Table 6.12 reports the contribution of each determinant to equilibrium inequality. Figures 6.14 and 6.15 plot these contributions and the resultant shares of total equilibrium inequality.

With respect to the economic size variables, the reported results consist of both the impact of the base long-run parameter and the slope dummy for a given year of the decomposition. These two elements are combined to give the long-run parameter for a specific year and represent the share of equilibrium inequality due to the economic size of both types of enterprises in a given year.

The decomposition results show that the economic size variables for both cropping and livestock enterprises contribute significantly to structural inequality in virtually every year. This result is expected – since income is generally a positive function of SGM, inequality in the economic size translates into income inequality. For most years, as established by the income model, the share of income attributed to these two variables is positive, which means that higher values of SGM are associated with higher equilibrium income.

Moreover, the concentration indices of the economic size ranked by initial income are also positive in most cases, showing that farms of bigger economic size as measured by SGM generally have higher equilibrium income levels. This is in line with the results of Phimister *et al*. (2004), who concluded that small economic size of farms was a characteristic which increases the probability of long low-income spells. There are few exceptions to this pattern. In both 1997 and 2008 the share of income due to cropping

Table 6.12 Equilibrium inequality decomposition, 1996-2009.

		Equilibrium parameter	*Share of income*	*Concentration index*	*Contribution*	*% share of eqilibrium inequality*
1996	*Cropping SGM*	**0,22** *	**0,12**	**0,36** ***	**0,04**	**12,1**
		0,21	*0,11*	*0,12*	*0,04*	
	Livestock SGM	**0,59**	**0,43**	**0,41** ***	**0,18**	**48,5**
		0,11	*0,09*	*0,04*	*0,05*	
	Fixed effect	**0,35** **	**0,33** ***	**0,43** **	**0,14** ***	**39,5**
		0,17	*0,11*	*0,21*	*0,04*	
	Constant	**4659,10** ***	**0,11** ***	**-**	**-**	**0,0**
		987,12	*0,03*	*-*	*-*	
	Equilibrium inequality	**-**	**-**	**-**	**0,37**	**100,0**
1997	*Cropping SGM*	**-0,25**	**-0,40**	**-0,19**	**0,08**	**16,7**
		0,14	*0,27*	*0,16*	*0,11*	
	Livestock SGM	**0,06**	**0,13** *	**0,38** ***	**0,05** *	**10,7**
		0,11	*0,25*	*0,03*	*0,09*	
	Fixed effect	**0,35** **	**0,97** ***	**0,34** *	**0,33** ***	**72,6**
		0,17	*0,33*	*0,20*	*0,12*	
	Constant	**4659,10** ***	**0,31** ***	**-**	**-**	**0,0**
		957,85	*0,09*	*-*	*-*	
	Equilibrium inequality	**-**	**-**	**-**	**0,45**	**100,0**
1998	*Cropping SGM*	**0,24**	**0,21** *	**0,56** ***	**0,12** *	**30,7**
		0,14	*0,12*	*0,04*	*0,07*	
	Livestock SGM	**0,17**	**0,17**	**0,26** ***	**0,05**	**12,0**
		0,11	*0,12*	*0,03*	*0,03*	
	Fixed effect	**0,35** **	**0,46** ***	**0,47**	**0,22** ***	**57,4**
		0,17	*0,17*	*0,76*	*0,07*	
	Constant	**4659,10** ***	**0,15** ***	**-**	**-**	**0,0**
		958,66	*0,03*	*-*	*-*	
	Equilibrium inequality	**-**	**-**	**-**	**0,38**	**100,0**
1999	*Cropping SGM*	**0,30** **	**0,30** **	**0,66** ***	**0,20** **	**45,7**
		0,15	*0,14*	*0,03*	*0,10*	
	Livestock SGM	**-0,01**	**-0,01**	**0,14** ***	**0,00**	**-0,4**
		0,11	*0,14*	*0,04*	*0,02*	
	Fixed effect	**0,35** **	**0,54** ***	**0,44**	**0,24** ***	**54,7**
		0,17	*0,20*	*0,37*	*0,09*	
	Constant	**4659,10** ***	**0,17** ***	**-**	**-**	**0,0**
		1005,64	*0,04*	*-*	*-*	
	Equilibrium inequality	**-**	**-**	**-**	**0,44**	**100,0**
2000	*Cropping SGM*	**0,15**	**0,13**	**0,47** ***	**0,06**	**17,4**
		0,15	*0,13*	*0,11*	*0,06*	
	Livestock SGM	**0,24** **	**0,26** **	**0,32** ***	**0,08** *	**23,0**
		0,12	*0,13*	*0,04*	*0,05*	
	Fixed effect	**0,35** **	**0,46** ***	**0,47**	**0,22** ***	**59,6**
		0,18	*0,18*	*1,10*	*0,07*	
	Constant	**4659,10** ***	**0,15** ***	**-**	**-**	**0,0**
		1010,32	*0,04*	*-*	*-*	
	Equilibrium inequality	**-**	**-**	**-**	**0,36**	**100,0**
2001	*Cropping SGM*	**0,04**	**0,03**	**0,24** **	**0,01**	**2,2**
		0,14	*0,11*	*0,12*	*0,03*	
	Livestock SGM	**0,57** ***	**0,47** ***	**0,43** ***	**0,20** ***	**54,0**
		0,12	*0,10*	*0,03*	*0,05*	
	Fixed effect	**0,35** **	**0,37** ***	**0,44**	**0,16** ***	**43,8**
		0,17	*0,14*	*0,55*	*0,05*	
	Constant	**4659,10** ***	**0,12** ***	**-**	**-**	**0,0**
		1004,85	*0,03*	*-*	*-*	
	Equilibrium inequality	**-**	**-**	**-**	**0,37**	**100,0**
2002	*Cropping SGM*	**0,17**	**0,17**	**0,56** ***	**0,10**	**24,0**
		0,15	*0,15*	*0,07*	*0,08*	
	Livestock SGM	**0,14**	**0,17**	**0,27** ***	**0,05**	**11,5**
		0,11	*0,13*	*0,04*	*0,04*	
	Fixed effect	**0,35** **	**0,49** **	**0,52**	**0,26** ***	**64,4**
		0,18	*0,20*	*2,74*	*0,09*	
	Constant	**4659,10** ***	**0,17** ***	**-**	**-**	**0,0**
		981,75	*0,04*	*-*	*-*	
	Equilibrium inequality	**-**	**-**	**-**	**0,40**	**100,0**

Year		Equilibrium parameter	Share of income	Concentration index	Contribution	% share of eqilibrium inequality
2003	*Cropping SGM*	**0,33** **	**0,26** **	**0,49** ***	**0,13** **	**35,0**
		0,14	*0,11*	*0,05*	*0,06*	
	Livestock SGM	**0,36** ***	**0,28** ***	**0,28** ***	**0,08** ***	**21,6**
		0,11	*0,09*	*0,03*	*0,03*	
	Fixed effect	**0,35** **	**0,34** **	**0,48**	**0,16** ***	**43,4**
		0,17	*0,14*	*3,08*	*0,06*	
	Constant	**4659,10** ***	**0,11** ***	**-**	**-**	**0,0**
		1006,39	*0,02*	*-*	*-*	
	Equilibrium inequality	**-**	**-**	**-**	**0,37**	**100,0**
2004	*Cropping SGM*	**0,05**	**0,05**	**0,18**	**0,01**	**2,2**
		0,15	*0,15*	*0,14*	*0,03*	
	Livestock SGM	**0,40** ***	**0,40** ***	**0,42** ***	**0,17** ***	**45,9**
		0,12	*0,12*	*0,04*	*0,06*	
	Fixed effect	**0,35** **	**0,42** **	**0,46**	**0,19** ***	**51,9**
		0,17	*0,18*	*0,44*	*0,06*	
	Constant	**4659,10** ***	**0,13** ***	**-**	**-**	**0,0**
		995,76	*0,03*	*-*	*-*	
	Equilibrium inequality	**-**	**-**	**-**	**0,37**	**100,0**
2005	*Cropping SGM*	**0,04**	**0,05**	**0,28** **	**0,01**	**3,8**
		0,14	*0,19*	*0,12*	*0,06*	
	Livestock SGM	**0,15**	**0,21**	**0,34** ***	**0,07**	**19,3**
		0,11	*0,15*	*0,05*	*0,05*	
	Fixed effect	**0,35** **	**0,56** **	**0,50**	**0,28** ***	**77,0**
		0,17	*0,23*	*0,53*	*0,08*	
	Constant	**4659,10** ***	**0,18** ***	**-**	**-**	**0,0**
		1032,44	*0,04*	*-*	*-*	
	Equilibrium inequality	**-**	**-**	**-**	**0,37**	**100,0**
2006	*Cropping SGM*	**0,52** ***	**0,37** ***	**0,58** ***	**0,22** ***	**55,9**
		0,16	*0,10*	*0,04*	*0,07*	
	Livestock SGM	**0,25** **	**0,20** **	**0,20** ***	**0,04** *	**10,5**
		0,11	*0,09*	*0,04*	*0,02*	
	Fixed effect	**0,35** **	**0,33** **	**0,40**	**0,13** **	**33,7**
		0,17	*0,13*	*1,13*	*0,06*	
	Constant	**4659,10** ***	**0,10** ***	**-**	**-**	**0,0**
		1021,74	*0,02*	*-*	*-*	
	Equilibrium inequality	**-**	**-**	**-**	**0,39**	**100,0**
2007	*Cropping SGM*	**0,90** ***	**0,44** ***	**0,59** ***	**0,26** ***	**65,0**
		0,16	*0,07*	*0,02*	*0,04*	
	Livestock SGM	**0,48** ***	**0,27** ***	**0,21** ***	**0,06** ***	**14,1**
		0,12	*0,07*	*0,03*	*0,02*	
	Fixed effect	**0,35** **	**0,22** **	**0,37**	**0,08** **	**20,9**
		0,17	*0,09*	*0,93*	*0,04*	
	Constant	**4659,10** ***	**0,07** ***	**-**	**-**	**0,0**
		992,69	*0,01*	*-*	*-*	
	Equilibrium inequality	**-**	**-**	**-**	**0,40**	**100,0**
2008	*Cropping SGM*	**-0,06**	**-0,06**	**-0,11**	**0,01**	**1,7**
		0,20	*0,21*	*0,24*	*0,07*	
	Livestock SGM	**0,50** ***	**0,53** ***	**0,49** ***	**0,26** ***	**62,1**
		0,12	*0,13*	*0,03*	*0,08*	
	Fixed effect	**0,35** **	**0,41** **	**0,37**	**0,15** **	**36,3**
		0,17	*0,19*	*0,74*	*0,06*	
	Constant	**4659,10** ***	**0,12** ***	**-**	**-**	**0,0**
		1000,62	*0,03*	*-*	*-*	
	Equilibrium inequality	**-**	**-**	**-**	**0,42**	**100,0**
2009	*Cropping SGM*	**0,32** **	**0,27** **	**0,48** ***	**0,13** **	**35,6**
		0,15	*0,12*	*0,08*	*0,07*	
	Livestock SGM	**0,41** **	**0,31** ***	**0,30** ***	**0,09** ***	**25,6**
		0,13	*0,10*	*0,05*	*0,04*	
	Fixed effect	**0,35** **	**0,33** **	**0,43**	**0,14** ***	**38,8**
		0,17	*0,14*	*0,36*	*0,05*	
	Constant	**4659,10** ***	**0,09** ***	**-**	**-**	**0,0**
		1012,97	*0,02*	*-*	*-*	
	Equilibrium inequality	**-**	**-**	**-**	**0,36**	**100,0**

Figure 6.14 Absolute contributions to equilibrium inequality.

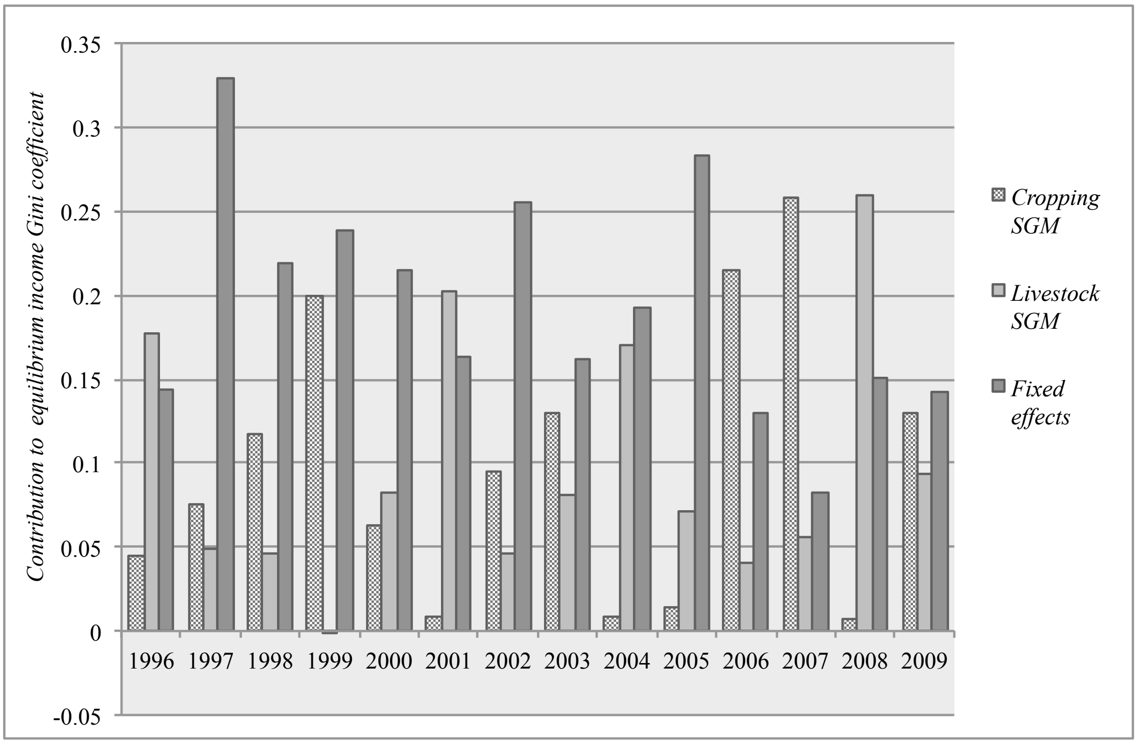
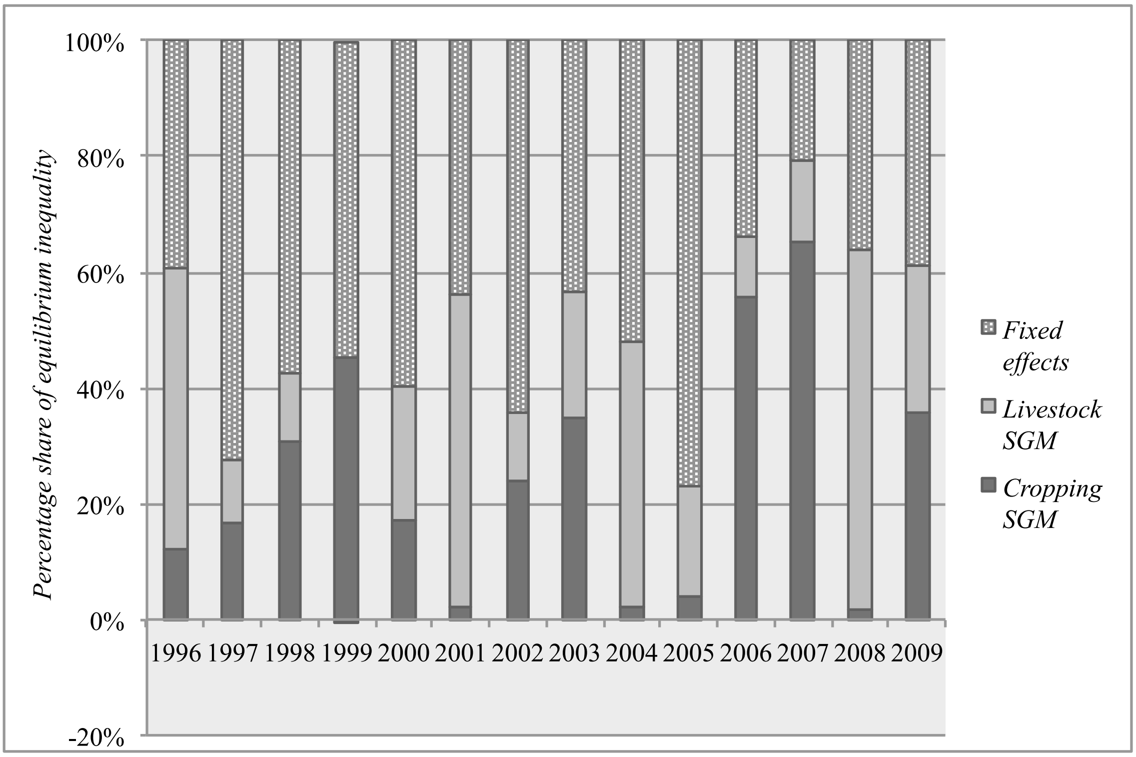


Figure 6.15 Percentage contributions to equilibrium inequality.



SGM is negative[57]. However, cropping SGM still contributed to inequality in these years since the negative share of income was associated with a negative concentration index between cropping SGM and income[58]. Overall, therefore, the unequal distribution of enterprise size served to increase the long-term inequality of farming incomes in all years except 1999, when the contribution of livestock economic size to inequality was slightly below zero. This has been the result of a slightly negative income share (close to zero) combined with a positive concentration index[59]. The role of the economic size of cropping and livestock enterprises in equilibrium inequality is not always statistically significant, with the contributions to Gini coefficient being statistically different from zero roughly half of the times.

Figures 6.14 and 6.15 show there is some variability in the size of the economic size contributions, however, overall, averaged across all the years, both cropping and livestock shares of the economic size account for around 25% of equilibrium inequality each. Therefore on average the economic size of farms is responsible for roughly half of the chronic inequality in the studied period. In other words, across the studied years, half of the equilibrium inequality within Scottish agricultural incomes was due to observable differences in the size of farm businesses, as measured by economic size units.

[57] The Scottish Governments economic reports show that these results reflect negative market conditions; in 1997 world commodity prices were in general low and in 2008 this was caused by steep decline in returns from cereal.
[58] Normally income is a positive function of cropping SGM, but it becomes a negative function of cropping SGM these years when it is not profitable. Because this effect was quite strong, it led to an overall negative correlation between the level of equilibrium income and the cropping SGM, so the concentration index for the two became negative in the two years.
[59] Unlike with the cropping result, the negative share of income from livestock SGM is negligible therefore it does not impact on the correlation index which remains positive.

This leaves the remaining half of structural inequality to be driven by farm-level fixed effects – a proportion that at first might seem surprisingly high. The contribution of the fixed effects term is consistently significant at 5% for all the years. In the income model used, the fixed effects term will represent two things. Firstly, it captures various factors that can affect farms‘ income generating performance but are hard to measure, and therefore are not controlled for in the model. The Scottish Government's *Scottish Farm Enterprise Performance Analysis* (RESAS, 2012) report facilitates the understanding of what exactly is included in these unobservable differences. As the report points out, there is a multitude of factors which affect farm's financial performance, including:

- natural constraints, like quality of land or weather,
- reasons for farming, for example financial or personal satisfaction,
- attitudes towards animal welfare and use of chemicals,
- farms fixed costs,
- interaction with other enterprises within the farm business,
- nature of contracts the farm has with food retailers or suppliers.

Secondly, fixed effects also capture differences in workforce composition and land ownership structure between farms, which are not taken into account in the calculation of SGM but will affect farms' incomes.

This result indicates that a big driver of chronic inequality in agricultural farming income in Scotland is differences in income generating performance of farms that are not linked to their economic size. This important role of fixed effects is consistent with the findings presented in the *Scottish Farm Enterprise Performance Analysis* (RESAS, *Ibid*.), which uses FAS 2010-2011 data. Scottish Government undertook the analysis of enterprise output and associated costs of crops and livestock in order to assess the financial performance of the main types of farm enterprises in Scotland.

The report‘s main finding is that there is substantial heterogeneity in farms‘ financial performance[60], irrespective of size, with high performers achieving better management of variable costs, higher sales per tonne of crops or head of animal, reflecting better quality, as well as higher yields linked to greater volume of output per hectare for cropping enterprises and a greater increase in value due to improved technical performance for livestock enterprises.

6.5 Conclusions

In studies on agricultural incomes distribution, the focus is usually on static analysis, with very few studies looking at the dynamics of inequality over time. Analysing inequality in a dynamic context is important in order to characterize the changes in inequality over time and what is driving these changes. What is more, studying the dynamics of incomes allows to determine whether inequalities are a transitory or chronic problem, which will influence implications for policy.

This chapter looked at the evolution of agricultural income distribution through the analysis of various aspects of mobility using data for the period of 1995/1996 – 2009/2010. The results showed high instability of agricultural incomes which was reflected in variability of income levels across the years. The relative inequality in

[60] Which is measured using three proxies: enterprise gross margin per head/hectare, the enterprise’s income, and output: input ratio which shows how much gross return there is per pound spent per single unit of output (head/hectare).

agricultural incomes is higher than for representative incomes in the Scottish population. The level of inequality has increased by 10% for balanced panel between 1996 and 2010, but this reflects the choice of particular years rather than systematic trend given the fluctuations in inequality levels over the years.

In order to better understand how the transitory shocks impact the inequality picture in Scottish agricultural incomes, the Shorrocks rigidity measure was calculated. This index corresponds to the concept of mobility as equalizer of longer-term incomes, and uses the comparison between inequality of longer-term average of incomes, and actual observed incomes which will include the fluctuations caused by transitory income shocks. As the measurement period is extended, the proportion of inequality determined by the long-term structure of the industry settles at 86%. This means that transitory shocks play some role in the inequality levels observed in any given year, but the structural inequality in the industry is substantial.

The concepts of mobility as positional movement and individual income growth were analysed by decomposing change in inequality between two points in time following Jenkins and van Kerm's (2006) approach. The expected income growth was consistently progressive for both annual and multiyear changes, implying that poorer farms benefited relatively more from positive income changes, or suffered less from negative ones. Robustness checks based on averaging the data showed some mixed results, but there was evidence that transitory shocks drive the progressivity result. As such, it can be concluded that while expected income growth was progressive, the structural change played minor role in this progressivity; larger role was played by transitory shocks that caused regression to the mean. This implies there is no systematic size bias in farms' growth, which indirectly supports Gibrat's law of proportionate effect suggesting that the rate of growth of an enterprise is unrelated to its size and therefore determined by random facts.

The decomposition of vertical mobility using the parameters of the ECM estimated in Chapter 5 provided additional insights into the drivers of individual income changes underlying the evolution of the agricultural income distribution. The contribution of growth in the economic size of farms to the vertical mobility was negligible reflecting the dominance of transitory shocks as a source of income changes. Measured over the multiyear change between 1996 and 2010, the impact of the economic size growth was mildly equalizing but still accounted for no more than 12% of total vertical mobility and was not statistically significant. This implies that the redistributive effects of structural change have been relatively minor even over a long time horizon, which is largely due to the relative small contribution of enterprise size changes to the overall growth in average income. This minor role of structural changes was consistent for pre and post-SFP multiyear changes in inequality.

The results further showed that the contribution from the disequilibrium adjustment was always equalizing, both for annual and multiyear analysis, implying that the long-run, or equilibrium, inequality of the industry is smaller than actual observed inequality. This was confirmed by the fact that the Gini coefficient of equilibrium incomes was consistently smaller than that of actual incomes. The deviations from equilibrium levels of income caused by idiosyncratic income shocks may be interpreted as measures of income risk, indicating the unpredictability of incomes and economic insecurity. The adjustment towards the equilibrium was the main force behind the equalizing impact of individual income growth, which was then enhanced or impaired by individual income shocks (which had a random and statistically insignificant effect), and to a much smaller extent, structural change.

Overall, the result of progressivity of income growth in agricultural incomes is not driven by the structural change in the industry; it is instead a result of transitory income shocks which cause a regression to the mean that appears to favour poorer farmers, because farms that face an adverse income shock in one year (and thus have unexpectedly low incomes) will have better growth prospects in the following year as a result. Therefore inequality changes in Scottish agricultural incomes are largely driven by the adjustment towards the underlying equilibrium relationship which incorporates income shocks common to all farmers in a given year, as well as the idiosyncratic income shocks experienced by individual farmers. Changes in the economic size of farms over time play a relatively minor role.

The decomposition of equilibrium inequality revealed the extent to which it is driven by the economic size of farms. While the contribution of the economic size to the equilibrium inequality varied between the years, on average over longer period it caused around half of the structural inequality. The positive impact of farms' economic size on inequality was expected given that income is a positive function of SGM, however the result indicates that only some of the differences between farmers' incomes come from differences in productive capacity. The remaining half of the inequality is due to non-observable farm or farmer characteristics affecting income generating performance unrelated to their economic size, and captured by fixed effects; examples include managerial ability and the quality of natural resources on farm. The contribution of fixed effects will also partially reflect the observable workforce composition and land ownership structure which are not taken into account in the SGM measure. This has policy implications for any solutions to structural inequality in the industry, since addressing farms' economic size differences will not eliminate the inequality entirely.

7 Conclusions

One of the founding goals of the CAP was “to ensure a fair standard of living for the agricultural community, in particular by increasing the individual earnings of persons engaged in agriculture” (Treaty of Rome, 1957). The CAP was formed as a continuation of national policies and initially consisted only of support in the form of market price measures, which determined its path of development for decades to come. Market price measures were initially successful at increasing production, which was welcomed after the World War II food shortages. However, soon enough the shortcomings of such a policy became apparent and European agriculture was beset with surpluses, which together with rising budgetary pressure served to increase criticism of the policy and pressure for reforms. The agricultural lobby existed prior to the CAP and became supranational with its creation; its actions meant that any reforms to the policy had high political costs, and this caused divergence between what the academic sector recommended and what policy makers actually did. Specifically, the idea of direct decoupled payments had already emerged in the academic sector in the 1960s, being perceived as an optimal form of subsidy that did not have the shortcomings of market price measures, and offered greater transparency and targeting potential. However, the process of reforming the policy was long and gradual. The market support measures were largely reduced and replaced with payments coupled to hectares planted and heads of livestock. Eventually, the decoupled direct payments were introduced in 2005 in the form of the SFP, which is independent from production and paid out on a per hectare basis.

Scotland opted for the historic model of the SFP, where the entitlement values received by farmers are determined by their individual historic levels of coupled support, and allow them to enjoy support levels comparable to those in the past. The government's choice of this solution was politically motivated by the intention to minimize changes in the distribution of support and, specifically, to avoid creating losers from the reform. However, the historic model of the SFP implementation has been widely criticized as unfair and increasingly hard to justify, and the post-2014 CAP reform obliges countries which opted for the historic model to switch to regional flat rate payments.

The introduction of decoupled direct payments made the distribution of support more transparent and open to manipulation, giving the policy potential to be targeted in order to meet different policy objectives. The policy's objectives evolved and multiplied over time, which together with different national views on what farmers should be rewarded for make the assessment of agricultural support in the EU difficult. Nevertheless, the improvement of the income position of the agricultural community was one of the founding objectives of the policy. Furthermore, equity and targeting were identified by the OECD (1998) as general operational criteria for agricultural policy evaluation and the European Commission has repeatedly expressed concerns over the inequitable distribution of farm income support. The common wisdom on the redistributive impact of the CAP is summarised by the OECD (2003), which argues that support does not alter the income distribution in significant way since the transfers are mainly based on production levels or production factors. In this context, the focus of this thesis was on the distribution of agricultural incomes and support in Scotland.

The empirical part of the thesis started by estimating the rate of capitalisation of the SFP into agricultural rent values in Scotland. The motivation behind this part of the study was the improvement of assumptions used in calculating net transfer values while measuring the redistributive effect of support later in the thesis. The use of the empirically obtained passthrough rate constituted an improvement over the approach used by Allanson (2008, Allanson and Rocchi (2008)) who, following the OECD (2003), assumed that a return from a unit increase in direct payments to individual inputs is equal to the farm-owned share of those inputs; in the case of the SFP for tenanted farmers this would imply zero passthrough. Relatively little empirical research on the capitalisation rate of the SFP exists, with no estimates for Scotland. As such, the empirical rate of capitalisation is of interest in its own right and it adds to the existing literature, providing an illustration of the SFP transfer efficiency in Scotland. By estimating a rent equation, it was established that the average rate of capitalisation is in the proximity of 15 pence per pound of the payment. This means that out of every pound received through the SFP, on average a tenant farmer keeps 85 pence and the landowner captures 15 pence. This figure is plausible since it lies between the 35% capitalisation rate for historic model as suggested by Kilian *et al.* (2008) and the 6% rate as reported by Ciaian *et al*. (2011); it is also very close to the results of Ciaian and Kancs (2012) and Van Herck and Vranken (2011) who analysed the capitalisation rate of the SAPS and obtained estimates of 20% and between 10% and 15% respectively.

The thesis moved on to analyse the impact of agricultural policy on income inequality by measuring and decomposing its redistributive effect. The majority of research done on the redistributive performance of agricultural transfers has largely focused on its vertical aspect. The methodology used in this thesis, based on Allanson (2008), not only measures if support is progressive, but also addresses the issue of horizontal inequalities in support provision, which is largely neglected by the pre-existing literature. Allanson analysed the redistributive effect of support in Scotland prior to 2005, and this thesis investigated how the redistributive performance of the policy was affected by the introduction of the SFP (with the use of improved procedures to calculate pre-support incomes). In addition to the analysis of actual support regime under the historic model of the SFP, the thesis analysed two counter-factual distributions of support; a flat rate of entitlements for the whole Scotland, or two rates of entitlements, with different values for LFA and non-LFA farms. The analysis of regional model redistribution is particularly useful in the context of the upcoming CAP reform, since Scotland will have to introduce a flat rate payment system of the SFP, and is most likely to opt for a solution along the lines of the LFA/non-LFA split of rates.

This analysis exposed the chronic dependence of Scottish agriculture on support, with more than half of farms making losses in the absence of support. The results further showed that the provision of support in Scottish agriculture increases absolute inequality. However, in spite of the historic link to support levels and hence volume of production, and the common belief that agricultural support rewards the most productive large farms, the support in Scotland under the historic model is actually progressive in absolute terms. This contradiction can be explained by the fact that agriculture in Scotland would be to a large extent a loss-making activity in the absence of support (particularly for some farm types), such that many farms would go out of business. The support was in fact regressive for the range of farms that would break even without it, but a large number of farms have negative pre-support incomes and the policy transfers keep them in business – the high progressivity of support for this range drives the overall result. In spite of this progressivity, the distribution of support increased absolute income differentials because of the presence of large classical horizontal inequalities. Specifically, the main source of these inequalities was the weakness of the relationship between pre-support incomes and transfer levels within each farm type, rather than systematic discrimination between farm types due to different commodity regimes. The policy implication of the large within-type horizontal inequalities is that policies designed to focus support on farms with low income by limiting the size of payments received by large farms under current arrangement, like for example modulation, would be largely ineffective (Allanson, 2008).

Overall, the redistributive performance of agricultural support did not change with the introduction of the SFP, since the results from the historic model analysis are comparable to those reported by Allanson (2008) for years 2001 – 2005. As such, the historic model met its initial objective not to drastically change the distribution of support in Scotland.

The analysis of the alternative scenarios of the SFP distribution showed that despite seeming fairer from a procedural point of view, the regional model would have increased inequality more than was the case with the historic model. Of the two scenarios considered in the study, the flat rate model was more unequal; the LFA/non-LFA split of rates scenario mitigated the disequalizing impact reflecting the intermediate nature of such a model.

The flat rate scenario resulted in increased progressivity of support, but it increased the inequality more than the historic model due to a sharp increase in between-type classical horizontal inequality. This was driven by a large redistribution of support towards Sheep and Sheep and Cattle farms, which on average are holdings of large land area (and hence with many entitlements) with low entitlement values under the historic model. All other farm types lose out from the flat rate, and this causes an increase in the number of farms with post-support losses. Thus the flat rate does not manage to make farms break even as well as the historic model and may therefore threaten the survival of some farms.

The analysis of the LFA/non-LFA version of the regional model suggests that using two rates rather than one could mitigate some of the problems of the flat rate scenario. The LFA/non-LFA model constitutes an intermediate solution which would have limited the extent of support redistribution relative to the historic model, as reflected in the smaller increase in the progressivity of support and lower between-type discrimination. This model of distribution also generated less post-support loss making farms in most years compared to the flat rate. However, while non-LFA holdings would benefit from differential rates, LFA farms other than Specialist Sheep and Sheep and Cattle farms would be highly disadvantaged, since averaging their entitlement values with low entitlement values of Specialist Sheep and Sheep and Cattle farms (without non-LFA farms bringing the average up) would significantly reduce their transfer levels.

The crucial policy conclusion from this set of results is that the sharp increase in discrimination between different farm types implies that the continued production of some commodities might be at risk under the regional model distribution. Policy makers and farms organisations have expressed concerns about the profitability of certain enterprises, most notably cattle production, under the regional model. These results give support to these concerns and suggest that policy makers in Scotland should consider using the coupled support options available under new post-2014 CAP regime. In particular, the concerns over profitability of cattle farming under the regional model are supported, since both flat rate and LFA/non-LFA versions make Specialist Cattle farms worse off, and the impact is worse under the latter scenario.

More generally, the choice of variable to indicate unobservable income-generating capacity is a crucial aspect of successful support targeting. Particularly, if the goal of agricultural policy is to ensure a minimum standard of living for farmers by supporting those with the lowest incomes, an indicator capable of identifying these farmers is necessary. The results of this analysis indicate that land is a poor choice, particularly in the light of heterogeneity of farms with regards to the relationship between land and productivity, and hence the income they are capable of generating. Therefore any solution looking to target the support in an efficient and effective manner would be dependent on finding an indicator for payment entitlements which is more strongly correlated to income generating capacity (Allanson, 2008). As such, splitting land into different quality types provides a marginal improvement over treating all land the same, but it does not solve the problems of flat rate, and creates even worse problems for some farms and the viability of cattle production. In this context, the historic model of the SFP seems to be performing better at targeting support to the most needing farms, since it results in the lowest percentage of post-support loss making holdings. Overall, further work is required to identify clear criteria and gain better information concerning the incidence and causes of financial problems among farms in order for the decoupled payments to become the most efficient solution, as suggested by the OECD (2003).

The static analysis described the income distribution at given points in time, revealing the disequalizing impact of agricultural support. However, a more comprehensive characterization of agricultural income situation can be obtained when static analysis is complemented by the study of the evolution of income distribution over time.

Agricultural income dynamics, particularly in Scotland, are a largely unexplored research topic. Indeed, the only study of Scottish agricultural income dynamics is performed by Phimister *et al*. (2004) for the period from 1998/1989 to 1999/2000. This thesis used data for years 1995/1996 to 2009/2010 to explore all four concepts of mobility (as distinguished by Jantti and Jenkins), providing a comprehensive analysis of the issue.

To set the ground for the analysis, an ECM of farm income was estimated in chapter 5; results from the model were subsequently used for regression-based decompositions of vertical mobility and equilibrium income inequality indices. The specification of the dynamic income function focused on the role played by the economic size of farms, which later on allowed analysing the role of structural change in inequality changes.

Over the sample period 1995/1996 – 2009/2010 average income level showed a considerable amount of variation, confirming the instability of agricultural incomes. The relative inequality in agricultural incomes is higher than for representative incomes in the Scottish population. The level of inequality has increased by 10% for balanced panel between 1996 and 2010, but this reflects the choice of particular years rather than systematic trend given the fluctuations in inequality level over the years. In general, the extent of inequality and redistribution observed in any particular year is influenced both by underlying structural factors and by temporary stochastic shocks to incomes. Discriminating between these two factors is crucial for policy design since the first requires action to deal with the chronic, structural problems that capture some farms in the low or negative incomes range, while the second might call for short-term assistance to tackle transitory problems of low or negative incomes on individual farms. The results indicated that transitory shocks affected the observed level of inequality to a moderate extent, with long-term structural inequality in the sector settling at 86% of cross-sectional inequality, as indicated by Shorrocks rigidity measure. The role of transitory shocks in observed levels of inequality was confirmed by the fact that the inequality of equilibrium incomes based on the empirical results from the ECM was consistently smaller than that of actual incomes. This finding points out the issue of income risk linked to the unpredictability of incomes and economic insecurity. In the presence of imperfect capital markets, which do not allow to smooth out intertemporal consumption, and risk-aversion of individuals, a more stable income flow with lower overall value will be preferred to a higher expected value with more fluctuations and uncertainty. What this result implies is that insurance mechanisms to smooth incomes would also serve to reduce inequality in annual farm incomes.

The results from the inequality change decomposition imply that expected individual income growth was consistently pro-poor; as such, the relative inequality increased when the disequalizing impact of the resulting reranking of individuals more than offset the equalizing impact of income growth. However, the sensitivity analysis suggested that the majority of the apparent progressivity in expected income growth was due to transitory shocks to incomes causing regression to the mean rather than due to structural change in the industry. The regression-based decomposition of vertical mobility index further confirmed that the progressivity of income growth in agricultural incomes is not driven by changes in the economic size of enterprises. Instead, the progressivity is largely a result of the adjustment towards the underlying, more equal, equilibrium relationship (which varies depending on shocks common to all farmers in a given year) and transitory income shocks experienced by individual farmers. Overall, these results do not provide evidence against Gibrat's law of no systematic size bias in terms of expected income growth rates.

The analysis of the determinants of equilibrium income inequality revealed that only half of it is due to differences in the economic size of farms, with the other half of it driven by farms' fixed effects that include factors such as managerial ability, farms' natural resources and structure of ownership of the production factors. Thus the fixed effects allow for differences between farms in converting the economic size of farms into income, and the results indicate these differences are substantial. This implies that the economic size of farms is not a sufficient indicator of farms' financial situation. Therefore while measures based on the economic size of enterprises could to some extent be used to target support to smaller and poorer farmers, the large role played by fixed effects suggests that such policies would not eliminate inequality entirely.

This result links with the large role played by within-type horizontal inequalities in the disequalizing redistributive effect of agricultural support in Scotland. Given the historic link between the levels of support received and the economic size of enterprises (through area and headage payments which served as a basis for the SFP entitlements), the large within-type inequality implies the differences between farms in productivity which disturb the one-to-one relationship between pre-support incomes and transfer levels. Thus these two results are a manifestation of the same phenomenon which indicates the difficulty for both eliminating structural inequality and targeting support with the use of policies that employ economic size variables as indicators.

In terms of final summary, the idea of support in the form of direct decoupled payments emerged in the academic sector already in the 1960s and it has been perceived as an optimal form of subsidies that do not have the shortcomings of market price measures. With some implementation difficulties, the idea was slowly put in practice in the EU. The current shape of the policy makes it both more open to manipulation for targeting purposes and to scrutiny in order to assess its performance. How it performs on other grounds is beyond the scope of this paper, but the inequality analysis shows that support increases absolute income differentials in the historic form of implementation. Switching to a flat rate of payments, which might seem more fair from procedural point of view, would results in even more inequalities. This shows that decoupled support performs poorly on equity grounds when past support levels determine its value, however, using land only as an indicator makes it even more disequalizing. The dynamic analysis further shows that introducing the decoupled payment did not significantly impact the mobility aspects of agricultural income. The instability of agricultural incomes has been an issue over the years, and the incidence of income shocks has dominant impact on inequality levels, with structural change playing a minor role both before and after introduction of the SFP. This suggests that in order to improve its equalizing performance, support should include explicit security mechanisms to protect farmers from transitory shocks.

The thesis also pointed out the difficulty of using the economic size of farms, which captures their productive capacity, to target support and design policy measures meant to eliminate the inequality in income distribution. What needs mentioning in the context of this discussion is the inherent trade-off between productivity and equity. While linking support to the economic size of farms might not solve the equity issues of agricultural income distribution, it will be consistent with the idea of awarding the most productive farmers for their provision of public goods and to compensate their higher costs linked to operating in highly regulated market, which some stakeholders of the agricultural policy stage are advocating (Pack, 2010b).

In terms of critical discussion of the thesis, the nature of the data used needs to be addressed. In spite of using weighted samples, there is always risk of biased sample which might produce unrepresentative results, particularly in the part of the analysis which uses limited samples. The fact that only full time farms are included in the FAS dataset means that the picture of broader agricultural community might be misrepresented, and the pluriactivity of farmers is played down. Furthermore, the inequality analysis will apply more to the profitability of farming rather than actual financial situation of farmers, seeing as many farms have additional sources of income but they are not included in the dataset. Furthermore, the analysis uses current agricultural incomes and the inequality of wealth is not taken into account, which might result in a misrepresentation of farmers' welfare. What is more, different measures of income will lead to different set of results; choice of cash income focuses on the income position as perceived by the farmers, but it does not control for the fact that farms which do not need to rent land and hire labour will be better off in the analysis which uses this measure. In terms of structural change analysis, the panel is rather narrow and stable in the sense that farms which undergo drastic size change are removed from the dataset or given another number, which makes them lose their earlier identity. This means that the results are likely to play down the real size of structural change happening in the sector.

The results of inequality analysis are always very sensitive to the choice of inequality measure. Accordingly, if measures with other degree of inequality aversions were used, the results would be different. Specifically, the shortcomings of the Gini coefficients are that it is most sensitive to inequalities in the middle of the income distribution and it is unable to differentiate different kinds of inequalities (Lorenz curves might intersect, which would reflect different patterns of income distribution, but they might still result in very similar values of the Gini coefficient) (De Maio, 2007). Furthermore, the analysis in chapter 4 focused on absolute inequality and in chapter 6 on relative inequality, while perhaps both types of inequality analysis for both chapters could provide a more comprehensive picture of the income distribution issues.

The weakness of the redistributive effect analysis in the thesis is that it does not endogenise the production choices to changes in policy when alternative support and pre-support distributions are analysed. Thus the work here could be taken forward by endogenising these impacts, along the lines of work by Deppermann *et al*. (2013).

In terms of the dynamic analysis, one might wish to study in more depth the nature of fixed effects to get a more detailed understanding of what is driving structural inequality so as to better inform the design of policy solutions to tackle farm income inequality. Furthermore, the decomposition of vertical mobility and equilibrium inequality could be done on an alternative dynamic model of income, where change in income is a function of different sources of income, including various types of agricultural support. Such an analysis would provide a more explicit assessment of agricultural policy's role in agricultural income inequality changes.

References

Ackrill, R., Kay A. and Morgan W. (2008) The CAP and its reform: The problem of reconciling budget and trade concerns. Canadian Journal of Agricultural Economics 56 (4): 393–411.

Allanson P. (1992) Farm size structure in England and Wales 1939-89. Journal of Agricultural Economics 43 (2): 137-148.

Allanson P. (1993) The impact of the modulation proposal in the MacSharry plan for reform of the cereals regime. European Review of Agricultural Economics 20: 99 -109.

Allanson P. (2005) The Impact of Farm Income Support on Absolute Inequality. European Association of Agricultural Economics, 94th Seminar, April 9-10, 2005, Ashford.

Allanson P. (2006) The Redistributive Effects of Agricultural Policy on Scottish Farm Incomes. Journal of Agricultural Economics 57: 117-128.

Allanson P. (2007) Classical Horizontal Inequalities in the Provision of Agricultural Income Support. Agricultural and Applied Economics Association 29 (4): 656-671.

Allanson P. (2008) On the characterisation and measurement of the redistributive effects of agricultural policy. Journal of Agricultural Economics 59: 169-187.

Allanson P., Gerdtham U.-G., Petrie D. (2010) Longitudinal analysis of income-related health inequality. Journal of Health Economics 29: 78–86.

Allanson P. and Petrie D. (2011) On decomposing the causes of changes in income-related health inequality with longitudinal data. SIRE Discussion Paper 2011-15, Scottish Institute for Research in Economics (SIRE).

Allanson P. and Petrie D., (2012a) On the choice of health inequality measure for the longitudinal analysis of income-related health inequalities. Health Economics 22: 353–365.

Allanson P. and Petrie D. (2012b) Understanding the vertical equity judgements underpinning health inequality measures. SIRE Discussion Paper 2012-06, Scottish Institute for Research in Economics (SIRE).

Allanson P. and Petrie D. (2013) Longitudinal methods to investigate the role of health determinants in the dynamics of income-related health inequality. Journal of Health Economics 32-5: 922-937.

Allanson P. and Rocchi B. (2008) An Analysis of the Redistributive Effects of Agricultural Policy in Tuscany with Comparative Results for Scotland. Review of Agricultural and Environmental Studies 86: 1-23.

Allen M., Downing E., Edwards, T., Seaton N., and Semple M. (2013) CAP Reform 2014–20: EU Agreement and Implementation in the UK and in Ireland. House of Commons Library RP13/64.

Alogsokoufis G., and Smith R. (1991) On Error Correction Models: Specification, Interpretation, Estimation. Journal of Economic Surveys 5: 97–128.

Amiel Y., F.A. Cowell F.A. and Polovin A. (1996) Inequality among the Kibbutzim, Economica 63(250, Supplement): 63-85.

Anderson T. W. and Hsiao C. (1981) Estimation of dynamic models with error components. Journal of the American Statistical Association 76: 598–606.

Anderson T. W, and Hsiao C. (1982) Formulation and estimation of dynamic models using panel data. Journal of Econometrics 18: 47–82.

Arellano M. and Bond S. R. (1991) Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. Review of Economic Studies 58: 277–297.

Aronson J. R., Johnson P., and Lambert P. J. (1994) Redistributive Effect and Unequal Income Tax Treatment. The Economic Journal 104: 262–70.

Atkinson A.B. (1970) On the Measurement of Inequality. Journal of Economic Theory 2: 244-63.

Atkinson A.B. (1980) Horizontal equity and the distribution of the tax burden. In H. Aaron and M.J. Boskin (eds.), The Economics of Taxation. Washington D.C., Brookings Institute: 3-18.

Atkinson A. B. and Bourguignon F. (1982) The comparison of multi-dimensioned distributions of economic status, Review of Economic Studies, 49, 183–201.

Atkinson A.B., Bourguignon F. and Morrisson C. (1992) Empirical Studies of Earnings Mobility. London: Harwood Academic Publishers.

Bakucs L. Z., Fertő I. (2009) Growth of family farms in a transition country – The Hungarian case. Agricultural Economics 40: 787-793.

Bakucs Z., Bojnec S., Fertő I. and Latruffe L. (2013) Farm size and growth in field crop and dairy farms in France, Hungary and Slovenia. Spanish Journal of Agricultural Research 11 (4): 869 – 881.

Bénabou R. and Ok E. A. (2001) Mobility as progressivity: ranking income processes according to equality of opportunity. Working Paper 8431, National Bureau of Economic Research, Cambridge, MA.

Benjamin C. and Phimister E. (2002) Does capital market structure affect farm investment? A comparison using French and British panel-level data. American Journal of Agricultural Economics 84 (4): 1115-1129.

Bhaskar A. and Beghin J. C. (2009) How coupled are decoupled farm payments? A review of the evidence. Journal of Agricultural and Resource Economics 34 (1): 130-153.

Blinder A. S. (1973) Wage Discrimination: Reduced Form and Structural Estimate. Journal of Human Resources 8: 436-455.

Blundell R. W., Bond S. R. (1998) Initial conditions and moment restrictions in dynamic panel data models. Journal of Econometrics 87: 115–143.

Bond S. R. (2002) Dynamic panel data models: a guide to micro data methods and practice. Portuguese Economic Journal 1: 141-162.

Bourgignon F., Fournier M., and Gurgand M. (1998). Distribution, development, and education: Taiwan, 1979-1994. Paper presented at LACEA Conference, Buenos Aires.

Bremmer J., Oude Lansink A. G. J. M., Olson K. D., Baltussen W. H. M., and Huire, R. B. M. (2002) Analysis of farm development in Dutch agriculture and horticulture. Paper presented at 13th Congress of the International Farm Management Association (IFMA) in National Sports and Conference Centre, Papendal, Wageningen, The Netherlands, July 7- 12, 2002.

Breustedt G. and Habermann H. (2010) The Incidence of EU Per-Hectare Payments on Farmland Rental Rates: A Spatial Econometric Analysis of German Farm-Level Data. Journal of Agricultural Economics 62 (1): 225-243.

Bromley D. W. and Hodge I. (1990) Private property rights and presumptive policy entitlements: reconsidering the premises of rural policy. European Review of Agricultural Economics, 17: 197-214.

Bruno, G. S. F. (2005) Approximating the bias of the LSDV estimator for dynamic unbalanced panel data model. Economic Letters 87 (3): 361–366.

Buckwell A. E. A. (1997) Towards a Common Agricultural and Rural Policy for Europe, *in:* "... je aermer eine Familie ist, einen desto groesseren Antheil von der Gesamtausgabe muss zur Beschaffung der Nahrung aufgewendet werden ...". Engale, E. Affairs, D.-G. F. E. A. F. (ed.). Brussels European Economy; Reports and Studies. (2nd ed.). p. 28–29.

Carlin T. A. and Reinsel E. I. (1973) Combining income and wealth: An analysis of farm family well-being. American Journal of Agricultural Economics 55 (1): 38-44.

Chamberlain G. (1980) Analysis of variance with qualitative data. Review of Economic Studies 47: 225–238.

Charles-Coll J.A. (2011) Understanding income inequality: concept, causes and measurement. International Journal of Economics and Management Science 1 (3): 17-28.

Ciaian P., Kancs d'A. and Swinnen Jo (2008) Static and Dynamic Distributional Effects of Decoupled Payments: SFPs in the EU. LICOS (Centre for Institutions and Economic Performance) Discussion Paper Series 207/2008. KU Leuven.

Ciaian P., Kancs d'A. and Michalek J. (2011) SPS capitalisation into land value: generalized propensity score evidence from the EU. LICOS (Centre for Institutions and Economic Performance) Discussion Paper Series 29311. KU Leuven.

Ciaian P. and Kancs d'A. (2012) The Capitalisation of Area Payments into Farmland Rents: Micro Evidence from the New EU Member States. Canadian Journal of Agricultural Economics 60 (4): 517-540.
Ciaian P. and Swinnen J. F. M. (2009) Credit market imperfections and the distribution of policy rents. American Journal of Agricultural Economics 91 (4): 1124-1139.

CKD Galbrait (2010) The Moonzie Rent Case.

Clark J. R. A. and Jones A. (1999) From policy insider to outcast? Comité des Organisations Professionnelles Agricoles, EU policymaking, and the EU's 'agri-environment regulation, *in: The Modalities of EU Governance*, Jones, A. and Clark, J. (1999) Environment and Planning C: Government and Policy 17 5: 637-653.

Clarke J.S., Fulton M. and Brown D. J. (1992) Gibrat's law and farm growth in Canada. Canadian Journal of Agricultural Economics 40: 55-70.

Cleveland W.S. and Devlin S.J., (1988) Locally Weighted Regression: An Approach to Regression Analysis by Local fitting. Journal of the American Statistical Association 83: 596-610.

Commission of the European Communities (1991) The development and future of the CAP. COM (91) 100 Final.

COPA (1995) Committee of Agricultural Organisations in the EU. Comité des Organisations Professionnelles Agricoles. Brussels.

COPA COGECA. Copa History. < http://www.copa-cogeca.be/CopaHistory.aspx>

Cordts W., Deerberg K., and Hanf C. H. (1984). Analysis of the Intrasectoral Income Differences in West German Agriculture. European Review of Agricultural Economics 11 (3): 323-342.

Cowell, F. A. (1989) Sampling variance and decomposable inequality measures. Journal of Econometrics 42 (1): 27-41.

Cowell F.A. (1995) *Measuring Inequality* (2nd edition). Harvester Wheatsheaf, Hemel Hempstead.

Cowell F. A. and Flachaire E. (2002) Sensitivity of inequality measures to extreme values. Distributional Analysis Discussion Paper, 60, STICERD, LSE.

Cowell F. and Schluter C. (1998a) Income Mobility: A Robust Approach, STICERD Discussion Paper No. DARP 37, London: LSE.

Cowell F. and Schluter C. (1998b) Measuring Income Mobility with Dirty Data. CASE/16. London: LSE.

Dasgupta P., Sen A., Starret D. (1973) Notes on the Measurement of Inequality. Journal of Economic Theory 6: 180-187.

Datt G. and Ravallion M. (1992) Growth and redistribution components of changes in poverty measures: a decomposition with applications to Brazil and India in the 1980s, Journal of Development Economics 38: 275–95.

Davidson J. E. H., Hendry D. F., Srba F. and Yeo J. S. (1987) Econometric modelling of the aggregate time series relationship between consumer's expenditure and income in the United Kingdom. Economic Journal 88: 661-692.

Deaton A. (1997) The Analysis of Household Surveys. Baltimore: Johns Hopkins.
Defra (2010) Definitions of Terms used in Farm Business Management.

Deppermann A., Grethe H. and Offermann F. (2013) Distributional effects of CAP liberalisation on western German farm incomes: an ex-ante analysis. European Review of Agricultural Economics 2013: 1–22.

De Maio F. G. (2007) Income Inequality Measures. Journal of Epidemiology & Community Health 61: 849-852.

De Wachter S. and Galiani S. (2006) Optimal income support targeting. International Tax Public Finance 13: 661-684.

Dinardo J., Fortin N. M. and Lemiux T. (1996) Labour market institutions and the distribution of wages, 1973 - 1992: a semi-parametric approach. Econometrica 64 (5): 1001-1044.

Duclos J. Y., Jalabert V. and Araar A. (2003) Classical horizontal inequality and reranking: An Integrating Approach. Research on Economic Inequality 10: 65-100.

Durker D. M. (2008) Econometric analysis of dynamic panel-data models using Stata. Summer North American Stata Users Group meeting, StataCorp.

Efron B. (1979) Bootstrap Methods: Another Look at the Jackknife. Annals of Statistics 7: 1-26.

Engel E. (1857) Die Productions- und Consumtionsverhältnisse des Königreichs Sachsen. Zeitschrift des statistischen Bureaus des Königlich Sächsischen Ministerium des Inneren 8–9: 28–29.

Erjavec E. and Dimitrievski D. (2006) EU CAP. Ohrid Seminar 14. Ljubljana University.

European Commission website < http://ec.europa.eu/index_en.htm >

European Commission (1985) Perspectives for the Common Agricultural Policy. Communication of the Commission to the Council and the Parliament.

European Commission (1991) The Development and Future of the CAP - Reflections Paper of the Commission. COM(91) 100 final, Brussels.

European Commission (2002) Communication form the Commission to the Council and the European Parliament on the Mid-term Review of the CAP, COM 394 final, Brussels.

European Commission (2008) Health Check of the CAP. Brussels.

European Commission (2009a) Agriculture and Rural Development. Rural Development Policy.

European Commission (2009b) Factsheet: The Simplified Area Payment Scheme.

European Commission (2011a) Agriculture and Rural Development. Farm Accounting Data Network.

European Commission (2011b) Evolution of CAP measures applied to the dairy sector.

European Commission (2011c) The CAP in perspective: from market intervention to policy innovation.

European Commission (2012) Eurostat: Statistics Explained < http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Glossary:Annual_work_unit_(AWU)>

European Commission (2013a) CAP reform – an explanation of the main elements, MEMO.

European Commission (2013b) Overview of the CAP reform 2014-2020.

European Parliament (2014) CAP 2014-2020 tools to enhance family farming: opportunities and limits. Directorate General for Internal Policies. Policy Department B: Structural and Cohesion Policies.

Fearne A. (1997) The History and Development of the CAP 1945-1990, *in: The CAP* Ritson & Harvey (eds.), Wellingford: CAB International.

Feldstein M. (1976) On the Theory of Tax Reform. Journal of Public Economics 6(1-2): 77-104.

Fennell R. (1973) *The CAP: A Synthesis of Opinion.* Wye, Center for European Agricultural Policy Studies.

Fields G. S. (2003) Accounting for Income Inequality and Its Changes: A New Method with Application to the Distribution of Earnings in the United States. Research in Labor Economics, 22: 1-38.

Fields, G. S. (2005) Does income mobility equalize longer-term incomes? New measures of an old concept. Department of Economics, Mimeo, Cornell University.

Fields G. S. (2008) Income mobility. Department of Economics, Mimeo, Cornell University.

Fields G. S. and Ok E. A. (1996) The Meaning and Measurement of Income Mobility. Journal of Economic Theory 71: 349-377.

Fields G. S. and Ok E. A. (1997) A subgroup decomposable measure of relative income mobility. Working paper, Cornell University.

Fields G. and Ok E. A. (1999) The measurement of income mobility: an introduction to the literature. In Handbook on Income Inequality Measurement, ed., J. Silber. Boston: Kluwer.

Fields G. and Ok E. A. (1999b) Measuring movement of incomes. Economica 66: 455–72.

Flannery M. J. and Hankins K. W. (2013). Estimating dynamic panel models in corporate finance. Journal of Corporate Finance 19: 1-19.

Floyd J. E. (1965) The Effects of Farm Price Supports on the Return to Land and Labor in Agriculture. Journal of Political Economy 73: 148-58.

Frandsen S.E., Gersfelt, B. and Jensen H.G. (2002) Decoupling Support in Agriculture: Impacts of redesigning European Agricultural Support. Fifth Annual Conference on Global Economic Analysis, June 5-7, Taipei, Taiwan.

Germond C. (2011) Obstacle to reform? Farm interest groups and the CAP, 1968-1984. EUSA conference, Boston, 2-5 March 2011

Gibrat R. (1931) Les inégalités économiques ; applications: aux inégalités des richesses, a la concentration des entreprises, aux populations des villes, aux statistiques des familles, etc., d'une loi nouvelle, la loi de l'effet proportionnel. Paris: Librairie du Recueil Sirey.

Gini C. (1912) *Variabilita e Mutabilita*. Bologna.

Gottschalk P. and Spolaore E. (2002) On the evaluation of economic mobility. Review of Economic Studies 69: 191–208.

Governmental Statistical Service, Scottish Executive (2002) Economic Report on

Scottish Agriculture.

Gravelle H. (2003) Measuring income related inequality in health: standardisation and the partial concentration index. Health Economics, 12: 803–819.

Hahn J., Hausman J., Kuersteiner G. (2007) Long difference instrumental variables estimation for dynamic panel models with fixed effects. Journal of Econometrics 140: 574–617.

Hansen L. P. (1982) Large sample properties of generalised method of moment estimators. Econometrica 50: 1029–1054.

Hardwick P. and Adams M. (2002) Firm size and growth in the UK life insurance industry. The Journal on Risk and Insurance 69(4): 577-593.

Harvey D. R. (1982) National interests and the CAP. Food Policy (August): 174-190.

Hastie T. and Loader C. (1993) Local regression: automatic kernel carpentry Statistical Science 8: 120-129.

Hendricks N. P, Janzen J. P. and Dhuyvetter K. C. (2012) Subsidy incidence and inertia and farmland rental markets: estimates from a dynamic panel. Journal of Agricultural and Resource Economics 37(3) :361–378.

Hergrenes A., Hill B., and Lien G. (2001) Income instability among farm households – evidence from Norway. Farm Management: Journal of the Institute of Agricultural Management 11 (1): 37-48.

Hill B. (1999) Farm Household Incomes: Perceptions and Statistics. Journal of Rural Studies 15 (3): 345-358.

Hill B. (2000) Farm incomes, wealth and agricultural policy. Ashgate Publishing Co., Brookfield, VT, 2000.

Hill B. (2005) *The new rural economy : change, dynamism and government policy*. The Institute of Economic Affairs ; in association with Profile Books.

Hoffmeyer E. (1958) Dollar Shortage and the Structure of U.S. foreign trade. North-Holland Publishing Company 1958. Amsterdam.

Hofreither M. F. (2007) The "Treaties of Rome" and the Development of the CAP. Institut fur nachhaltige Wirtschafttensentwicklung.

Hofreither M. F., Salhofer, K. & Sinabell F. (1996) Der Agrarsektor Osterreichs: Stutzung und politische Macht. *Politik und Wirtschaft in den neunziger Jahren.*

Holtz-Eakin D., Newey W., Rosen H. S. (1988) Estimating vector autoregressions with panel data. Econometrica 56: 1371–1396.

Hoskin T. (no date) Parametric and non-parametric: demystifying the terms. Mayo Clinic Department of Health Sciences Research.

Institute for Agriculture and Trade Policy. (2007) The CAP: a Brief Introduction. Global Dialogue Meeting. Washington, D.C.

Janssen L. and Button B. (2004) Impacts of Federal farm program payments on cropland values and rental rates: evidence from county-level data in South Dakota. American Agricultural Economics Association Annual Meeting, Denver, Colorado, August 1 – 4, 2004.

Jantti M. and Jenkins S. (2013) Income mobility. Discussion paper series, the Institute for the Study of Labour (IZA).

Jarvis S. and Jenkins S. (1998) How much income mobility is there in Britain? Economic Journal 108: 1–16.

Jenkins S. P. (1988) Reranking and the Analysis of Income Redistribution. Scottish Journal of Political Economy 35: 65-76.

Jenkins S. P. and Lambert P. J. (1999) Horizontal Inequity Measure: a Basic Reassessment, *in*: Handbook in Income Inequality Measurement. J. Silber, ed., 535 - 556. Boston: Kluwer Academic.

Jenkins S. P. and Van Kerm P. (2006) Trends in income inequality, pro-poor income growth and income mobility. Oxford Economic Papers 58 (3): 531–548.

Jenkins S. P. and Van Kerm P. (2008) Has income growth in Britain become more pro-poor? Paper presented at the 30th General Conference of the International Association for Research on Income and Wealth, August 24-30 2008, Portoroz, Slovenia.

Jenkins S. P. and Van Kerm P. (2011) Trends in individual income growth: measurement methods and British evidence. ISER Working Paper Series 2011-06, Institute for Social and Economic Research.

Kakwani N. C., (1977b) Measurement of Progressivity: An International Comparison. The Economic Journal 87: 71-80.

Kakwani N. C. (1984) On the measurement of tax progressivity and redistributive effect of taxes with applications to horizontal and vertical equity. Advances in Econometrics 3: 149-68.

Kakwani N. C. (1993) Poverty and economic growth with application to Côte d'Ivoire. Review of Income and Wealth 39: 121–39.

Kakwani N. C. (2000) Growth and poverty reduction: an empirical analysis. Asian Development Review 18: 353–8.

Kakwani N. C. and Lambert P. J. (1999) Measuring income tax discrimination. Review of Economics and Statistics 81: 27-31.

Keele L. and De Boef S. (2004) Not just for cointegration: Error Correction Models with stationary data. Nuffield College University of Oxford Politics Discussion Papers Series.

Keeney M. (2000) The distributional impact of direct payments on Irish farm incomes. Journal of Agricultural Economics 51: 252-265.

Kilian S., Antón J., Röder N. and Salhofer K. (2008) Impacts of 2003 CAP Reform on Land Prices: From Theory to Empirical Results. European Association of Agricultural Economists Conference Paper, 44808.

Kilian S. and Salhofer K. (2008) Single Payments of the CAP: Where Do the Rents Go? Agricultural Economics Review 9(2): 96-106.

Kirwan B. E. (2005) Essays on U.S. Agricultural Policy: Subsidies, Crop Insurance, and Environmental Auctions. PhD dissertation, Massachusetts Institute of Technology.

Kirwan B. E. (2009) The Incidence of U.S. Agricultural Subsidies on Farmland Rental Rates. Journal of Political Economy 117(1):138-164.

Kiviet J. F. (1995) On bias, inconsistency, and efficiency of various estimators in dynamic panel data models. Journal of Econometrics 68: 53-78.

Koester U. and Tangermann S. (1977). Supplementing farm price policy by direct income payments: Cost-benefit analysis of alternative farm policies with a special application to German agriculture. *European Review of Agricultural Economics 4:* 7-31.

Koning N. (2006) Agriculture, Development and International Trade: Lessons to Be Learned from the CAP of the EU. Resaeau des Organisations Paysennes et de Producteurs Agricoles de L'Afrique de L'Ouest.

Kostov P., Patton M., Mcerlean S., Moss J., (2006) Does Gibrat's Law hold amongst dairy farmers in Northern Ireland? 11th Congress of European Association of Agricultural Economists, Copenhagen, Denmark, 24-27 August.

Krugman, P. (1992) The rich, the right, and the facts. American Prospect 11: 19–31.

Lambert P.J. (2001) The Distribution and Redistribution of Income: A Mathematical Analysis. Manchester: Manchester University Press, 3rd edition.

Lambert, M.D., Griffin, T.W., 2004. Analysis of government farm subsidies on farmland cash rental rates using a fixed effect spatial distributed lag model and a translog cost model, *in*: Paper Presented at the American Agricultural Economics Association Annual Meeting, Denver, Colorado.

Latruffe L. and Le Mouël Ch. (2009) Capitalization of government support in agricultural land prices: what do we know? Journal of Economic Surveys 23 (4): 659-691.

Lence S. H. and Mishra A. K. (2003) The Impacts of Different Farm Programs on Cash Rents. American Journal of Agricultural Economics 85: 753-761.

Lerman R. I. and Yitzhaki S. (1989) Improving the accuracy of estimates of Gini coefficients. Journal of Econometrics 42: 43-47.

Litchfield J. A. (1999) Inequality: methods and tools. World Bank's Web Site on Inequality, Poverty, and Socio-economic Performance: http://www.worldbank.org/poverty/inequal/index.htm

Lotti F., Santarelli E. and Vivarelli M. (2003) Does Gibrat's Law hold among young, small firms? Journal of Evolutionary Economics 13 (3): 213-235.

Manna R. and Regoli A. (2012) Regression-based approaches for the decomposition of income inequality in Italy, 1998-2008. Rivista di statistica ufficiale 14(1): 5-18.

Mansholt S. Year (1963) Regional Agreements for Agricultural Markets, *in:* Eleventh International Conference for Agricultural Economics, London. Oxford University Press.

Mavromaras K., Sloane P. and Wei Z. (2013) The Scarring Effects of Unemployment, Low Pay and Skills Under-utilisation in Australia Compared. Institute for the Study of Labour Discussion Paper Series 7440.

Milward A. S. (1994) The Europeanization of Agricultural Protection. *The European Rescue of the Nation-State.* TJ Press (Podsatow) Ltd.

Mishra A. K. and Goodwin B. K. (1997) Farm Income Variability and the Supply of Off- farm Labor. American Journal of Agricultural Economics 79 (3): 880-887.

Mishra A. K., El-Osta H. S., Morehart M. J., Johnson J. D. and Hopkins J. W. (2002) Income, Wealth, and the Economic Well-Being of Farm Households. Farm Sector Performance and Well-Being Branch, Resource. Economics Division, Economic Research Service, U.S. Department of Agriculture. Agricultural Economic Report No. 812.

Moore T. G. (1987) Farm policy: justifications, failures and the need for reform.

Morduch J. and Sicular T. (2002) Rethinking Inequality Decomposition, with Evidence from Rural China. The Economic Journal 112: 93-106.

Moreddu C. (2011) Distribution of Support and Income in Agriculture. OECD Food, Agriculture and Fisheries Working Papers, No. 46, OECD Publishing.

Mrak M. and Rant V. (2008) Financial Perspective 2007-2013: Domination of National Interests. European Commission website. http://ec.europa.eu/dgs/policy_advisers/conference_docs/mrak_m_rant_dom_national_interests.pdf

Mundlak Y. (1978) On the pooling of time series and cross-section data. Econometrica 46: 69–85.

Musgrave R. A. (1959) The Theory of Public Finance. McGraw-Hill, New-York.

Nash E.F. (1965) A policy for agriculture, *in: Agricultural Policy in Britain. Selected Papers.* McCrone G., Attwood E.A. (Eds.). University of Wales Press, Cardiff (Originally published *in*: Seldon, A. Agenda for a Free Society. Hutchinson for the Institute of Economic Affairs, London).

Nickell S., (1981) Biases in dynamic models with fixed effects. Econometrica 49: 1417–1426.

Oaxaca, R. (1973) Male-female wage differences in urban labour markets. International Economic Review 14 (3): 693 - 709.

Olson M. (1965) The Logic of Collective Action: Public Goods and the Theory of Groups. Harvard University Press, Cambridge, Massachusetts.

Organisation for Economic Co-operation and Development (OECD) (1998) Agriculture in a Changing World: Which Policies for Tomorrow? Press communiqué (98) 22. Paris, OECD Publications.

Organisation for Economic Co-operation and Development (OECD) (2003) Farm household income: issues and policy responses. Paris, OECD Publications.

Organisation for Economic Co-operation and Development (OECD) (2005) Dairy policy reform and trade liberalisation. Paris, OECD Publications.

Organisation for Economic Co-operation and Development (OECD) (2011) OECD Agricultural database, 2011 ed. Paris, OECD publications.

Pack B. (2010a) Inquiry into Future Support for Agriculture in Scotland. The Interim Report. The Scottish Government, Edinburgh.

Pack B. (2010b) The road ahead for Scotland. Final report of the inquiry into future support for agriculture in Scotland. The Scottish Government, Edinburgh.

Pate E. (2014) 'New Madness' risks creating slipper farmers, says Miller. The Courier, May 1, 2014.

Patton M., Kostov P., McErlean S. and Moss J. (2008) Assessing the influence of direct payments on the rental value of agricultural land. Food Policy 33: 397-405.

Petrick M. (2008) The Co-evolution of Semantics and Policy Paradigms: 50 Years of Europe's CAP. Intereconomics 43**:** 246-252.

Petrie D., Allanson P. and Gerdtham U. G. (2011) Accounting for the dead in the longitudinal analysis of income-related health inequalities. Journal of Health Economics 30 (5): 1113-1123.

Phimister E., Roberts D. and Gilbert A. (2004) The dynamics of farm incomes: panel data analysis using the Farm Accounts Survey. Journal of Agricultural Economics 55 (2): 197-220.

Plotnick R. (1981) A measure of horizontal equity. Review of Economics and Statistics 63: 283-88.

Podder N. (1993) The disaggregation of the Gini coefficient by factor components and its applications to Australia. Review of Income and Wealth 39 (1): 51-61.

Podder N. and Chatterjee S. (1998). Sharing the National Cake in Post Reform New Zealand: Income Inequality Trends in Terms of Income Sources. Paper Presented at the Annual Conference of the New Zealand Association of Economics, Government Buildings, Wellington, 2.04.1998.

Rao V. (1969) Two decompositions of concentration ratio. Journal of Royal Statistical Society Series A 132 (3): 418-25.

Ravallion M. and Chen S. (2003) Measuring pro-poor growth. Economics Letters 78: 93–99.

Reform the CAP (2009) Is cross compliance an effective policy?

Reform the CAP (2010) Member States.

Roberts M., Kirwan B. E., and Hopkins J. (2003) The Incidence of Government Program Payments on Agricultural Land Rents: The Challenges of Identification. American Journal of Agricultural Economics 85: 762-69.

Rocchi B., Romano D. and Stefani G., (2005) Distributive impacts of alternative agricultural policies: a SAM based analysis for Italy. Cahiers d'Economie et Sociologie Rurales, 77: 86-112.

Rodriguez J.S., Salas R. and Perrote I. (2004) Partial Horizontal Inequality Orderings: A Non-Parametric Approach. Fundación Centro de Estudios Andalucen Working Paper No. E2004/01.

Rohde N, Tang K. K. and Rao P. (2010) Income inequality, mobility and economic insecurity in Australia. The University of Queensland School of Economics Discussion Paper Series 407.

Ross S.A. (1981) Some stronger measures of risk aversion in the small and in the large with applications. Econometrica 49: 621-663.

Ruiz-Castillo J. (2004) The measurement of structural and exchange income mobility. Journal of Economic Inequality 2: 219–228.

Rural and Environment Science and Analytical Services (RESAS) (2012) Scottish farm enterprise performance analysis: additional analysis of the 2010-11 Farm Accounts Survey. Agriculture Statistics.

Ryan J., Barnard C., and Collender R. (2001) Government Payments to Farmers Contribute to Rising Land Values. Economic Research Service, United States Department of Agriculture. Agricultural Outlook.

Sargan J. D. (1958) The estimation of economic relationships using instrumental variables. Econometrica 26: 329–338

Sargan J. D. (1988) Testing for misspecification after estimation using instrumental variables, *in: Contributions to econometrics*, Maasoumi E. (ed.): John Denis Sargan, Vol. I. Cambridge University Press, Cambridge.

Sasieni P. (1998) An adaptive variable span running line smoother. Stata Technical Bulletin 41: 4–7.

Schmid E., Sinabell F. and Hofreither M.F. (2006) Direct Payments of the CAP – Distribution Across Farm Holdings in the EU and Effects on Farm Household Incomes in Austria. Institut für nachhaltige Wirtschaftsentwicklung Discussion Paper No. DP-19-2006.

Schumpeter J. (1955) Imperialism and Social Classes. New York: Meridian Books.
Scottish Executive Environment and Rural Affairs Department (SEERAD) (2001) Economic Report on Scottish Agriculture 2001 Edition. Edinburgh: Governmental Economic Service.

Scottish Executive Environment and Rural Affairs Department (SEERAD) (2002) Economic Report on Scottish Agriculture 2002 Edition. Edinburgh: Governmental Economic Service.

Scottish Executive Environment and Rural Affairs Department (SEERAD) (2003) Economic Report on Scottish Agriculture 2003 Edition. Edinburgh: Governmental Economic Service.

Scottish Executive Environment and Rural Affairs Department (SEERAD) (2004) Economic Report on Scottish Agriculture 2004 Edition. Edinburgh: Governmental Economic Service.

Scottish Executive Environment and Rural Affairs Department (SEERAD) (2005) Economic Report on Scottish Agriculture 2005 Edition. Edinburgh: Governmental Economic Service.

Scottish Executive Environment and Rural Affairs Department (SEERAD) (2006) Economic Report on Scottish Agriculture 2006 Edition. Edinburgh: Governmental Economic Service.

Scottish Executive Environment and Rural Affairs Department (SEERAD) (2007) Economic Report on Scottish Agriculture 2007 Edition. Edinburgh: Governmental Economic Service.

Scottish Government Rural and Environment Research and Analysis Directorate (SGRERAD) (2008) Economic Report on Scottish Agriculture 2008 Edition. Edinburgh: National Statistics.

Scottish Government Rural and Environment Research and Analysis Directorate (SGRERAD) (2009) Economic Report on Scottish Agriculture 2009 Edition. Edinburgh: National Statistics.

Scottish Government Rural and Environment Research and Analysis Directorate (SGRERAD) (2010) Economic Report on Scottish Agriculture 2010 Edition. Edinburgh: National Statistics.

Scottish Government Rural and Environment Research and Analysis Directorate (SGRERAD) (2011) Economic Report on Scottish Agriculture 2011 Edition. Edinburgh: National Statistics.

Scottish Government Rural and Environment Research and Analysis Directorate (SGRERAD) (2012) Economic Report on Scottish Agriculture 2012 Edition. Edinburgh: National Statistics.
Scottish Government (2010) Risk and Risk Management Strategies in Agriculture: An Overview of the Evidence.

Scottish Government (2013a) Social welfare, income and poverty, main analyses.

Scottish Government (2013b) Summary Guide to Scottish Agricultural Rent Reviews.

Scottish Government (2013c) Tenanted Agricultural Land in Scotland 2012. Edinburgh.

Scottish Land Court (2010) Decisions. R W Morrison-Low v The Executors of the Late T H Paterson.

Sen A. (1973) On Economic Inequality. Oxford, Clarendon Press.

Severini S. and Tantari A. (2013) The impact of agricultural policy on farm income concentration: the case of regional implementation of the CAP direct payments in Italy. Agricultural Economics 44: 275–286.

Shaik S., Helmers G. A. and Atwood J. A. (2005) The Evolution of Farm Programs and Their Contribution to Agricultural Land Values. American Journal of Agricultural Economics 87**:** 1190-1197.

Shapiro D., Bollman R. D. and Ehrensaft P. (1987) Farm size and growth in Canada. American Journal of Agricultural Economics 69: 477-483.

Shorrocks A. F. (1978a) Income Inequality and Income Mobility. Journal of Economic Theory 19: 376-393.

Shorrocks A. F. (1978b) The measurement of mobility. Econometrica 46: 1013–24.

Shorrocks A. F. (1982) Inequality Decomposition by Factor Components. Econometric

Society 50(1): 193-211.

Shorrocks A. F. (1983) The impact of income components on the distribution of family Incomes. Quarterly Journal of Economics 98 (2): 311-326.

Shorrocks A. F. (1984) Inequality Decomposition by Population Subgroups. Econometrica 52-6: 1369-1385.

Slemrod J. (1992) Taxation and inequality: a time-exposure perspective, *in: Tax Policy and the Economy*, Poterba, J. Vol. 6, ed. Cambridge, MA: MIT Press for the NBER.

Swinnen J. F. M. (2009a) On the Future of Direct Payments. Bureau of Economic Policy Advisors Workshop on Reflections on the CAP From a Long-Run Perspective Paper, Brussels.

Swinnen J. F. M. (2009b) Compensation payments in EU agriculture. Paper prepared for World Bank Project on “Adjustment costs to trade”.

Swinnen J. F. M., Ciaian P. and Kancs d’A. (2009) Study on the Functioning of Land Markets in the EU Member States under the Influence of Measures Applied under the Common Agricultural Policy. Centre for European Policy Studies (CEPR), Brussels.

Sutton J. (1997) Gibrat’s Legacy. Journal of Economic Literature 35: 40-59.

Tracy M. (1976) Fifty Years of Agricultural Policy. *Journal of Agricultural Economics* 27**:** 331-350.

Tracy M. (1993) *Food and Agriculture in Market Economy: An Introduction to Theory, Practice and Policy.* La Hutte, Agricultural Policy Studies.

Tracy M. (1994) The Spirit of Stresa. *European Review of Agricultural Economics* 21**:** 357-374.

The Treaty of Rome (1957) source: http://ec.europa.eu/economy_finance/emu_history/documents/treaties/rometreaty2.pdf

Tsui K.-Y. (1996) Growth-equity decomposition of a change in poverty: an axiomatic approach. Economics Letters 50: 417–23.

Upton M. and Haworth S. (1987) The growth of farms. European Review of Agricultural Economics 14: 351-366.

Wagstaff A., Van Doorslaer E. and Watanabe N. (2003) On decomposing the causes of health sector inequalities with an application to malnutrition inequalities in Vietnam. Journal of Econometrics 112,: 207 – 223.

Waterhouse R. (2013) The future CAP Pillar 1. Scottish Government.

Weiss C. R. (1998) Size, growth, and survival in the upper Austrian farm sector. Small

Business Economics 10: 305-312.

Weiss C. R. (1999) Farm growth and survival: econometric evidence for individual farms in Upper Austria. American Journal of Agricultural Economics 81: 103-116.

Wintoki M. B., Linck J. S., Netter J. (2012) Endogeneity and the dynamics of internal corporate governance. Journal of Financial Economics 105: 581–606.

Woolard I. and Klasen S. (2005) Determinants of Income Mobility and Household Poverty Dynamics in South Africa Journal of Development Studies 41 (5): 865-897.

Wooldridge J. M. (2005) Unobserved heterogeneity and estimation of average partial effects, *in:* Andrews D. W. K., Stock J. H. (Eds.) *Identification and Inference for Econometric Models: Essays in Honor of Thomas Rothenberg*. Cambridge University Press, Cambridge, 27–55.

Wooldridge J. M. (2009) An Introduction to Econometrics. South-Western Cengage Learning.

Van Herck K. and Vranken L. (2011) Direct payments and rent extraction by land owners: Evidence from New Member States. Paper prepared for the 122nd EAAE Seminar Evidence-based agricultural and rural policy making: Methodological and empirical challenges of policy evaluation. Ancona, February 17-18, 2011.

Vrolijk H. C. J., de Bont C. J. A. M., van der Veen H. B., Wisman J. H., and Poppe K. J. (2009) Volatility of farm incomes, prices and yields in the EU. LEI Waneningen University Report.

Von Witzke H. and Noleppa S. (2007) Agricultural and Trade Policy Reform and Inequality: The Distributive Effects of Direct Payments to German Farmers under the EU's New CAP. Working paper, Humboldt University Berlin, Institute for Agricultural Economic and Social Sciences.

Xu K. and Osberg L. (2002) The social welfare implications, decomposability, and geometry of the Sen family of poverty indices. Canadian Journal of Economics 35: 138–52.

Yitzhaki S. (1983) On an extension of the Gini inequality index, International Economic Review 24: 617–28.

Yitzhaki S. and Wodon Q. (2004) Mobility, Inequality and Horizontal Equity, *in:* John A. Bishop and Yoram Amiel (ed.) Studies on Economic Well-Being: Essays in the Honor of John P. Formby (Research on Economic Inequality, Volume 12), Emerald Group Publishing Limited, 179-199.

Zheng B. and Agresti A. (2000) Summarizing the Predictive Power of a Generalized Linear Model. Statistics in Medicine 19: 1771-1781.

Zobbe H. (2001) The Economic and Historical Foundation of the CAP in Europe. *Unit of Economics Working Papers.* Royal Veterinary and Agricultural University, Food and Resource Economic Institute.

List of Abbreviations

AB	Arellano-Bond
ADLM	Autoregressive Distributed Lag Model
BB	Blundell-Bond
BSE	Bovine spongiform encephalopathy (aka mad cow disease)
CAP	Common Agricultural Policy
COGECA	General Confederation of Agricultural Cooperatives
COPA	Committee of Professional Agricultural Organisations
ECC	European Economic Community
ECM	Error Correction Model
FADN	Farm Accountancy Data Network
FAS	Farm Accounts Survey
FMD	Foot-and-Mouth Disease
FE	Fixed Effects
GATT	General Agreement on Tariffs and Trade
HI	Horizontal Inequality
LCA	Land Capability for Agriculture
LFA	Less-Favoured Areas
LSDVC	Bias-corrected Least Square Dummy Variable
NC	National Ceiling
OECD	Organisation for Cooperation and Development
OLS	Ordinary Least Squares
OLSfe	Ordinary Least Squares with fixed effects modelled
RESAS	Rural and Environment Science and Analytical Services
SAC	Scottish Agricultural College
SAPS	Simplified Area Payment Scheme
SEERAD	Scottish Executive Environment and Rural Affairs Department
SFP	Single Farm Payment
SGM	Standard Gross Margin
SGRERAD	Scottish Government Rural and Environment Research and Analysis Directorate
SPS	Single Payment Scheme